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TABLES

Tables should be composed as text files, exactly at printing size (see under Illustrations), using a *sans-serif* font not smaller than 8-9 pts. Avoid thick borders and heavy grids. They are referred to in the text as Tab. (e.g. **Tab. 2**, **Tabs 3-6**, not **Tab.**). Abbreviations are explained in the captions or under Material and methods. Tables are kept as separate files, not embedded in the text.

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Family Cardiidae Lamarck, 1809

Subfamily Cardiinae Lamarck, 1809

Genus *Acanthocardia* Gray, 1853

(type species *Cardium aculeatum* Linné, 1758)

Cardium indicum Lamarck, 1819

(Fig. 1. A-D, Fig. 2. C)

Cardium hians Brocchi, 1814: p. 508, tav. 13, fig. 6 (non Spengler, 1799).

Cardium indicum Lamarck, 1819: p. 4.

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Esempi di bibliografia:

SALAS C., 1996. Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions. *Haliotis*, **25**: 33-100.

GRILL B. & ZUSCHIN M., 2001. Modern shallow- to deep-water bivalve death assemblages in the Red Sea – ecology and biogeography. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **168**: 75-96.

BOSS K.J., 1982. Mollusca, in Parker S.P. (ed.), *Synopsis and Classification of Living Organisms*. Vol. 1. McGraw-Hill, New York: 945-1166.

CARTER J.G., CAMPBELL D.C. & CAMPBELL M.R. 2000. Cladistic perspectives on early bivalve evolution, in Harper E.M., Taylor J.D. & Crame J.A. (eds), *The Evolutionary Biology of the Bivalvia*. *Geological Society, London, Special Publications*, **177**: 47-95.

VOKES H.E., 1980. *Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and update)*. Paleontological Research Institution, Ithaca, Edwards Brothers Inc., 307 pp.

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Book review

JOHN TAYLOR AND EMILY GLOVER, 2021. Biology, evolution and generic review of the chemosymbiotic bivalve family Lucinidae. The Ray Society, London, United Kingdom, 318 pp., 138 + color & b/w illustrations. ISBN 978-0-903874-53-3. Hardcover: 98 £.

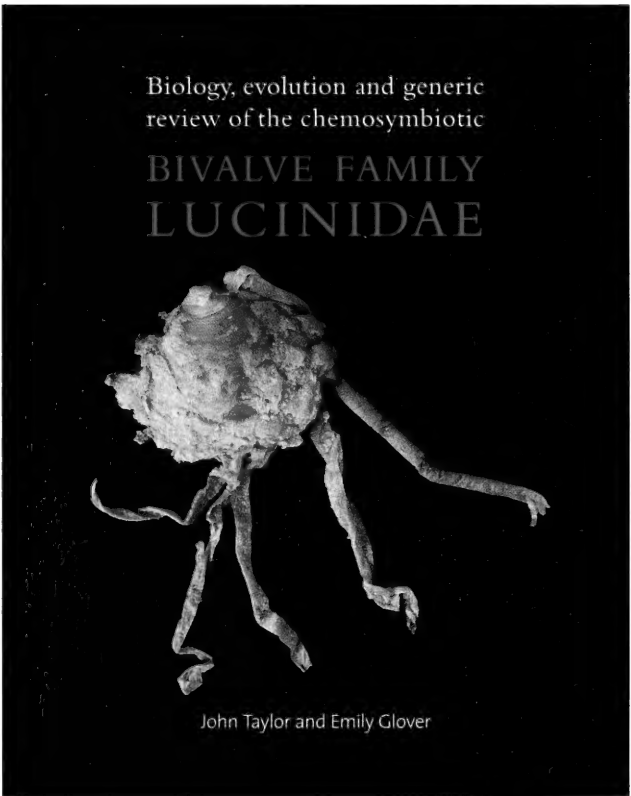
Discovered only 40 years ago, chemosymbiosis is the association between bacteria and some invertebrates, where bacteria provide most of the energy for the invertebrate's nutrition via inorganic chemical reactions. Chemosymbiosis enables life where there is no sunlight, and thus energy cannot be produced by photosynthesis, like in the depths of the ocean, but is common also in shallow water wherever there is availability of suitable chemicals to power chemosynthesis.

Lucinidae is the most diverse family of chemosymbiotic molluscs, with over 400 living species. This book comes after 20 years of work by the authors and is a major review of their biology and genus-level taxonomy. The book is arranged in two main sections: an introductory part that reports on their morphology, anatomy, ecology, biogeography and evolution, and a systematic part that covers all genera. The first section is extremely informative and lets the reader familiarize with this amazing family. The second section is impressive: all the 96 genera enjoy an in-depth treatment including the type species, a description, a list of the species currently included in the genus, the distribution and habitat, and the phylogenetic position. In addition, one or multiple large figures for each genus illustrate the type and additional species, highlighting their diagnostic characters. All together these are 138 figures of impressive quality that include both color and scanning electron microscopy images. Occasionally, some illustrations of the animals in-situ are provided, such as *Bretskyia scapula* occurring in coconut husk. Particularly remarkable is the image of *Rasta thiophila*, appropriately used also as cover image on the dust jacket, with the periostracum tubes that are believed to form the conduits for the passage of interstitial water into the mantle cavity and onto the ctenidia housing the symbiont bacteria. Also the introductory part is illustrated with useful large and clear color figures. The book has also a section on fossils and even one on the human utilization of these bivalves (did you know that in the Philippines there are even eating competitions of lucinids?!). At the end, there are also fourteen small-font-typed pages of references. For the bibliophile, I wish to add that the book is solidly bound in

red cloth with silver titles and decorations, with a color dust jacket.

Overall this is really an impressive work, very useful to the scientist but also to the shell collector for its extensive iconography. I am aware that a good book review should also cover imperfections or errors, but the only flaw I could spot is the low resolution of figure 24...

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- da) nel Pliocene senese. *Bollettino Malacologico*, **25** (9–12): 315–328. (1989).
- SPADINI V., 2006. Il genere *Clanculus* Monfort, 1810 (Gastropoda: Trochidae) nel Pliocene senese (Toscana, Italia). *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano*, **147** (II): 211–237.
- SPADINI V., 2021. The genus *Gibbula* Risso, 1826 (Trochidae: Cantharidinae) from the Pliocene of Siena. *Bollettino Malacologico*, **57**: 82–91.
- WoRMS EDITORIAL BOARD, 2021. World Register of Marine Species. Available from <http://www.marinespecies.org> at VLIZ. Accessed 2021-04-15. doi:10.14284/170.

- CHIRLI C., 2006. *Malacofauna Pliocenica Toscana*. 5. *Caenogastropoda*. C. Chirli Ed., 144 pp, 46 pls. Arti Grafiche BMB, Firenze.
- CHIRLI C., 2014. *Malacofauna Pliocenica Toscana*. 10. *Bivalvia Pteriomorpha* Beurlen, 1894. Chirli ed., 219 pp, 35 pls. Tipografia Vanzi, Colle di val d'Elsa (Siena).
- CHIRLI C., 2015. *Malacofauna Pliocenica Toscana*. 10. *Bivalvia heteroconchia* Hertwig, 1895. Chirli Ed., 233 pp, 32 pls. Tipografia Vanzi, Colle di val d'Elsa (Siena).
- CHIRLI C. & LINSE U., 2011. *The Pleistocene Marine Gastropods of Rhodes Islands (Greece)*. Chirli & Linse Eds., 447 pp., 90 pls, Arti Grafiche BMB, Firenze.
- BERTARELLI C. & INZANI A., 1985. Ritrovamento di *Nerita* (*Amphinerita*?) *zatinii* n.sp. nel Pliocene toscano. *Bollettino Malacologico*, **21** (10–12): 295–300.
- DELL'ANGELO B. & FORLI M., 1995. Rinvenimento di piastre anomale di *Chiton saeniensis* Laghi, 1984 (Mollusca: Polyplacophora). *Bollettino Malacologico*, **31** (1–4): 77–80.
- FORLI M., DELL'ANGELO B., BERTINI D. & CIAPPELLI F., 2003a. Segnalazione di gasteropodi poco frequenti per il Pliocene Toscano. Contributo II. *Bollettino Malacologico*, **38** (9–12): 139–144. (2002).
- FORLI M., DELL'ANGELO B., CIAPPELLI F. & TAVIANI M., 2003b. A new species of *Haliotidae* (Mollusca, Vetigastropoda) in the Italian Pliocene. *Bollettino Malacologico*, **38** (9–12): 149–154. (2002).
- FORLI M., DELL'ANGELO B., MONTAGNA P. & TAVIANI M., 2004. A new large *Patella* (Mollusca: Archaeogastropoda) in the Pliocene of the Mediterranean Basin. *Bollettino Malacologico*, **40** (1–4): 49–78.
- GHISOTTI F. & MELONE G., 1975. Catalogo illustrato delle conchiglie marine del Mediterraneo 5. *Conchiglie, Notiziario mensile della Unione Malacologica Italiana*, **11** (11–12): 147–208.
- GOFAS S. & JABAUD A., 1997. The relationships of the mediterranean trochid gastropods '*Monodonta*' *mutabilis* (Philippi, 1846) and '*Gibbula*' *richardi* (Payraudeau, 1826). *Journal of Molluscan Studies*, **63**: 57–64.
- HORNUNG A., 1920. Res Ligusticae. XLIII. Gastèropodes fossiles du Rio Torsero (Ceriale), Pliocène inférieur de la Ligurie. *Annali Museo civico Storia naturale Giacomo Doria*, **3**, **9** (XLIX): 70–92.
- JUÁREZ J. & MATAMALES-ANDREU R., 2016. Tàxons inèdits o poc coneguts per al Pleistocè superior litoral de Mallorca (Illes Balears, Mediterrani occidental) i consideracions sobre alguns jaciments. *Bolletí de la Societat d'Història Natural de les Balears*, **59**: 39–67.
- LAGHI G.F., 1984. Sorprendente densità di *Chiton saeniensis* n. sp. in sabbie gialle plioceniche dei dintorni di Serre di Rapollano (Siena). *Bollettino del Museo Regionale di Scienze Naturali, Torino*, **2** (2): 555–564.
- LAMARCK, [J.-B. M.] DE., 1822. *Histoire naturelle des animaux sans vertèbres*. Tome septième. Published by the Author, 711 pp, Paris.
- LANDAU B., MARQUET R. & GRIGIS M., 2003. The Early Gastropoda (Mollusca) of Estepona, souther Spain. Part 1: Vetigastropoda. *Palaeontos*, **3**: 1–87.
- LANDAU B., MARQUET R. & GRIGIS M., 2004. The Early Gastropoda (Mollusca) of Estepona, souther Spain. Part 2: Orthogastropoda, Neotaenioglossa. *Palaeontos*, **4**: 1–108.
- LANDAU B., DA SILVA C. M. & MAYORAL E., 2011. The Lower Pliocene Gastropods of the Huelva sands Formation, Guadalquivir Basin, Southwestern Spain. *Paleofocus*, **4**: 1–90.
- LANDAU B. M. & JANSEN A., 2015. Additions to the gastropod fauna of the Pliocene of Estepona, southwestern Spain, 3. The genus *Plesiothyreus* Cossmann, 1888 (Phenacolepadiidae), with a note on its presence in the Middle Miocene of Winterwijk, Miste, The Netherlands. *Cainozoic Research*, **15** (1–2): 123–126.
- LINNAEUS C., 1758. *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata [10th revised edition], vol. 1: 824 pp. Laurentius Salvius: Holmiae.
- MALATESTA A., 1943. Le formazioni pleistoceniche del livornese. *Atti Società Toscana di Scienze Naturali*, **51**: 145–206.
- MALATESTA A., 1960. *Malacofauna pleistocenica di Grammichele (Sicilia)*. Parte 1a. *Memorie per servire alla Descrizione della carta Geologica d'Italia*, **12**: 1–196.
- MONEGATTI, P., RAFFI, S., 2001. Taxonomic diversity and stratigraphic distribution of Mediterranean Pliocene bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **165**: 171–193.
- NALDI F., DELLA BELLA G. & SCARPONI D., 2013. *Bela pseudoapeliusi* n. sp. (Neogastropoda: Mangeliidae) from the Plio-Pleistocene of Italy. *Bollettino della Società Paleontologica Italiana*, **52** (3): x–x.
- PAYRAUDEAU B. C., 1826. *Catalogue descriptif et méthodique des annelides et des mollusques de l'Île de Corse; avec huit planches représentant quatre-vingt-huit espèces, dont soixante-huit nouvelles*. 218 pp., Paris.
- PHILIPPI R. A., 1846–1855. *Die Kreiselschnecken oder Trochoideen (Gattungen Turbo, Trochus, Solarium, Rotella, Delphinula, Phasianella)*. In *Abbildungen nach der Natur mit Beschreibungen*. In: Küster, H. C.; Ed. *Systematisches Conchylien Cabinet von Martini und Chemnitz. Zweiten Bandes, dritte Abtheilung*. 2 (3): 1–372, pl. 1–49. Nürnberg: Bauer & Raspe.
- RUGGIERI G. & GRECO A., 1965. Studi geologici e paleontologici su capo Milazzo con particolare riguardo al Milazziano. *Geologica Romana*, **4**: 41–88.
- SACCO F., 1895. *I Molluschi dei terreni terziarii del Piemonte e della Liguria*. Parte 18. (Melaniidae, Littorinidae, Fossaridae, Rissoiidae, Hydrobiidae, Paludinidae e Valvatidae). 51 pp., 1 pl, Carlo Clausen, Torino.
- SACCO F., 1896. *I Molluschi dei terreni terziarii del Piemonte e della Liguria*. Parte 21. (Naricidae, Modulidae, Phasianellidae, Turbinidae, Trochidae, Delphinulidae, Cyclostremastidae e Tornidae). 60 pp., 4 pls, Carlo Clausen, Torino.
- SACCO F., 1904. *I Molluschi dei terreni terziarii del Piemonte e della Liguria*. Parte 30. Aggiunte e correzioni. *Considerazioni Generali. Indice Generale dell'Opera*. xxxvi + 203 pp., 31 pls, Carlo Clausen, Torino.
- SAMI M. & TAVIANI M., 1997. Lower Pleistocene record of the boreal guest *Macoma obliqua* (Sowerby, 1817) from the Romagna Apennine (N Italy). *Bollettino della Società Paleontologica Italiana*, (1996) **35** (3): 277–280.
- SOUSA R., DELGADO J., GONZÁLES J. A., FREITAS M. & HENRIQUES P., 2017. Marine Snails of the Genus *Phorcus*: Biology and Ecology of Sentinel Species for Human Impacts on the Rocky Shores. *Biological Resources of Water*, (7) 141–167. <http://dx.doi.org/10.5772/intechopen.71614>
- SPADINI V., 1986. Contributo alla conoscenza dei Trochidae (Gastropoda: Archaeogastropoda) del Senese: specie nuove o poco conosciute. *Bollettino Malacologico*, **22** (1–4): 85–90.
- SPADINI V., 1987a. Nota ai trochidi del senese: *Gibbula* (*Colliculus*) *turbinoides* (Deshayes, 1832) e *Gibbula* (*Tumulus*) *umbilicaris* (L., 1758). *Bollettino Malacologico*, **23** (1–4): 92–94.
- SPADINI V., 1987b. Ritrovamento di *Gibbula* (*Phorcus*) *distefanoi* Crema, 1903 nei sedimenti del Pliocene senese. *Bollettino Malacologico*, **23** (9–10): 307–310.
- SPADINI V., 1987c. Ritrovamento di *Gibbula* (*Forskaelena*) *depressa* (Sacco, 1896) e considerazioni sul sottogenere *Forskaelena* Iredale, 1918 nei terreni pliocenici del Senese. *Bollettino Malacologico*, **23** (11–12): 430–432.
- SPADINI V., 1990. Il genere *Conus* (Gastropoda: Neogastropo-

Material examined

Two spcms from Stroncoli (Bk2), in yellow sands, dimensions L 10 mm, L 14 mm.

Remarks

Previously known as *Gadinia garnoti*, described by Payraudeau, 1826 (Original name *Pileopsis garnotii*). First report in the Tuscan Pliocene.

Distribution

Pliocene (Piacenzian) Astigiano (Piedmont) (Sacco, 1904); (Piacenzian), Stroncoli, Terre Rosse area (Siena, Tuscany) (this paper). Lower Pleistocene: Monte Mario (Roma, Lazio), Italy (Cerulli-Irelli, 1910). Upper Pleistocene: Italy, (Appelius, 1871, Malatesta, 1943, Ruggieri & Greco, 1965), Spain, Mallorca (Juárez & Matamales–Andreu, 2016) Recent: from Mediterranean to west Africa.

Conclusions

The paleoenvironmental reconstruction is not our main purpose, but the molluscs we report are indicative of a rocky intertidal zone. These reports slightly expand the list of species exclusive to the intertidal zone on rocky bottoms in the Terre Rosse area (Tab. 1). In this habitat, the fossilization is an uncommon occurrence and, for this reason, these gastropods are scarcely represented in the fossil record. In these Pliocene outcrops, their remains can be found, more or less easily, in the prevailing thanatocoenosis with marine fauna attributable to habitats correlated to infralittoral sands and gravels bottoms alternating with *Posidonia* meadows, with variable depths up to the littoral zone. Many other species were reported before for the same outcrops, e.g. Polyplacophora, with relative

abundance of *Chiton saeniensis* Laghi, 1984 and Gastropoda, (Bertarelli & Inzani, 1985) (Spadini, 1986; 1987a–c; 1990; 2021) (Forli et al., 2003a, 2003b; Forli et al., 2004). However, there is currently a lack of a list including bivalves (some occasional reports can be found in Chirli, 2014; 2015) and a paleo–ecological analysis would also be desirable.

Aknowledgements

We are grateful to Carlo Chirli (Tavarnelle, Firenze) for his help with bibliographic research. The authors wish to thank the Editor-in-Chief Paolo G. Albano, and Stefano Dominici, Museo di Storia Naturale, University of Florence, and an anonymous referee for useful criticism on the manuscript.

References

AFFENZELLER S., HAAR N. & STEINER G., 2017. Revision of the genus complex *Gibbula*: an integrative approach to delineating the Eastern Mediterranean genera *Gibbula* Risso, 1826, *Steromphala* Gray, 1847, and *Phorcus* Risso, 1826 using DNA barcoding and geometric morphometrics (Vetigastropoda, Trochoidea). *Organisms Diversity & Evolution*, 17:789–812.

BORN I. VON., 1778. *Index rerum naturalium Musei Cæsarei Vindobonensis. Pars I.ma. Testacea. Verzeichniß der natürlichen Seltenheiten des k. k. Naturalien Cabinets zu Wien. Erster Theil. Schalthiere.* [1–40], 1–458, [1–82]. Vindobonae [Vienna]; (Kraus).

CERULLI-IRELLI S., 1910. Fauna malacologica mariana. *Palaeontographia Italica*, 16: 23–70.

CHIRLI C., 2000. *Malacofauna Pliocenica Toscana. Vol. 2. Superfamiglia Muricoidea.* C. Chirli Ed., 143 pp, 49 pls. Stamperia e Legatoria Pisana, Agnano Pisano.

CHIRLI C., 2004. *Malacofauna Pliocenica Toscana. Vol. 4. Archaeogastropoda.* C. Chirli Ed., 113 pp, 41 pls. Arti Grafiche BMB, Firenze.

Species	Campino	Stroncoli	Habitat
<i>Patella alessiae</i> Forli et al., 2004		*	intertidal on rocky shore
<i>Patella caerulea</i> Linnaeus, 1758	*	*	intertidal to a few m depth, on rocky shore
<i>Phorcus</i> cfr <i>mutabilis</i> (Philippi, 1851)		*	intertidal to a few m depth, on rocky shore
<i>Phorcus richardi</i> (Payraudeau, 1826)	*	*	intertidal to 20 m depth, on rocky shore, pebbles or <i>Posidonia</i> rhizomes
<i>Phorcus turbinatus</i> (Born, 1778)		*	intertidal to a few m depth, on rocky shore
<i>Echinolittorina ariesensis</i> (Fontannes, 1880)		*	intertidal on rocky shore (high–tide zone)
<i>Tectarius striatus</i> (King & Broderip, 1832)		*	intertidal on rocky shore
<i>Nerita zatini</i> Bertarelli & Inzani, 1985	*	*	intertidal on rocky shore
<i>Plesiothyreus pliogenicus</i> (Chirli, 2004)		*	intertidal on rocky shore
<i>Williamia pliogliustica</i> Forli, et al., 2009		*	lower intertidal to shallow subtidal zones but can be found also on the <i>Posidonia</i> rhizomes
<i>Trimusculus mammillaris</i> (Linnaeus, 1758)		*	intertidal on rocky shore (high–tide zone)

Table 1. Gastropods related to the intertidal zone, in Terre Rosse area (Siena).

Rio Torsero (Savona), Borzoli (Genova), Liguria. Upper Pliocene: (Piacenzian), Stroncoli, Terre Rosse area (Siena) (this paper), Pietrafitta (Siena), Italy (Forli et al., 2009).

Order Ellobiida
Superfamily Ellobioidea L. Pfeiffer, 1854 (1822)
Family Trimusculidae J. Q. Burch, 1945 (1840)
Genus *Trimusculus* F. C. Schmidt, 1818

Trimusculus mammillaris (Linnaeus, 1758)
(Fig. 6 F, G, L-N)

Type species: *Patella mammillaris* Linnaeus, 1758 accepted as *Trimusculus mammillaris* (Linnaeus, 1758) (type by subsequent designation). Recent, Mediterranean Sea, West Africa.

1758 *Patella mammillaris* Linnaeus, p. 782.
1904 *Gadinia garnoti* var. *pliocapuloidea* Sacco, p. 133, pl. 26, fig. 24.
1910 *Gadinia garnoti* Payr. – Cerulli-Irelli: p. 222, pl. 34, fig. 50
1965 *Trimusculus garnoti* (Payr.) – Ruggieri & Greco: p. 53, pl. 2, fig. 5.

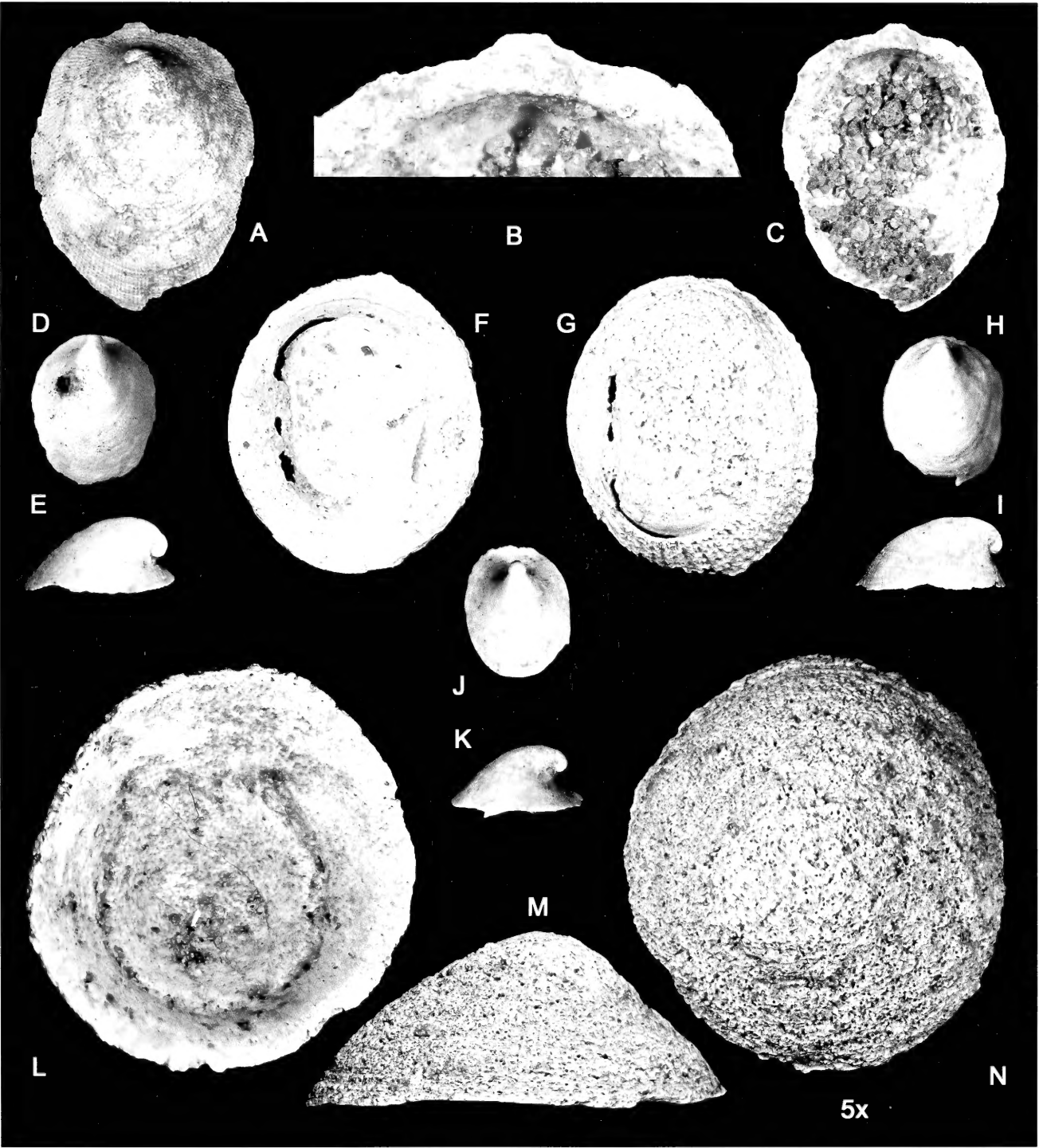


Fig. 6. A–C *Plesiothyreus pliocenicus* (Chirli, 2004) (A, C) L 4.8 mm (B) detail of the denticles on the internal posterior margin, L 2 mm. D, E, H–K *Williamia pliologustica* Forli et al., 2009 (D, E) L 2.5 mm; (H, I) L 2.2 mm (J, K) L 2.5 mm. F, G, L–N *Trimusculus mammillaris* (Linnaeus, 1758) (F, G) L 10 mm (L–N) L 14 mm. All the spcms are from Stroncoli (Bk2), Terre Rosse (Siena, Tuscany, Italy), Pliocene (Piacenzian).

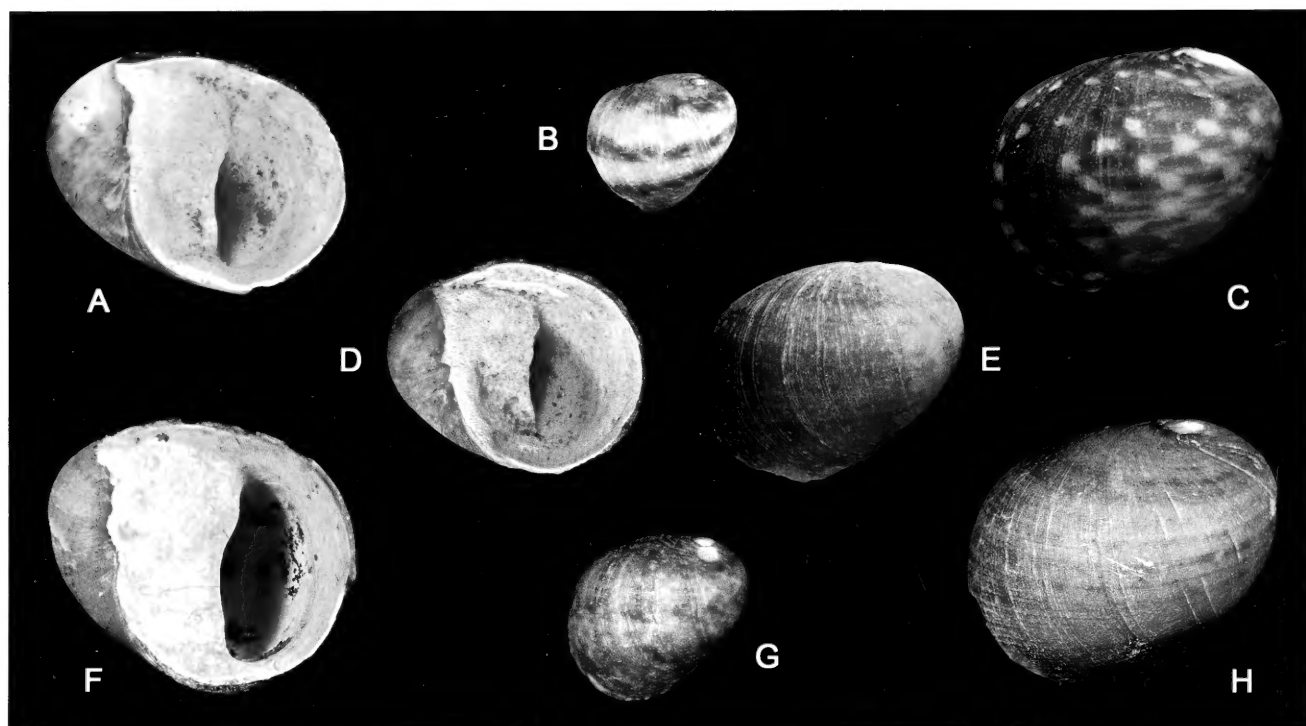


Fig. 5. A–H *Nerita zatirii* Bertarelli & Inzani, 1985 (A, C) W 13.5 mm (B) W 7 mm (D, E) W 11.5 mm (F, H) W 13.7 mm (G) W 8 mm. All the spcms are from Campino (Bk1), Terre Rosse (Siena, Tuscany, Italy), Pliocene (Piacenzian).

accepted as *Plesiothyreus parmophoroides* (Cossmann, 1885) (type by original designation). Upper Eocene, Paris basin, type locality Auvers (France).

2004 *Neopilina pliocenica* Chirli, p. 18, pl. 7, figs 1–3.

2006 *Plesiothyreus pliogenicus* Chirli, p. 124, pl. 46, figs 1–6.

2011 *Plesiothyreus pliogenicus* (Chirli) – Chirli & Linse: p. 29, pl. 2, figs 2a–d.

2015 *Plesiothyreus pliogenicus* (Chirli) – Landau & Jansen: p. 124, figs 1–5.

Material examined

Seven spcms, in yellow sands, from Stroncoli (Bk2), average dimensions L 4.5 mm.

Remarks

Second record from the Tuscan Pliocene of this very rare species. Its rarity in Tuscany is certainly due to its habitat, which, like most Phenacolepadids, probably consists of rocky substrates in tide pools. This species is reported also for Pliocene assemblages of Estepona (Spain) where it is common (Landau & Jansen, 2015). These authors also discuss its generic attribution and, for this topic, we refer to them.

Distribution

Pliocene: Ponte a' mattoni, San Gimignano (Siena) (Chirli, 2004). Upper Pliocene: (Piacenzian), Stroncoli, Terre Rosse area (Siena), Italy (this paper). Estepona (Spain) (Landau & Jansen, 2015). Lower Pleistocene: Kritika, Rhodes Island (Greece) (Chirli & Linse, 2011).

Subclass Heterobranchia Burmeister, 1837

Order Siphonariida (Not documented)

Superfamily Siphonarioidea Gray, 1827

Family Siphonariidae Gray, 1827

Genus *Williamia* Monterosato, 1884

Williamia pliologustica Forli, Dell'Angelo,
Sosso & Bonfitto, 2009
(Fig. 6. D, E, H–K)

Type species: *Ancylus gussoni* O. G. Costa, 1829 accepted as *Williamia gussoni* (O. G. Costa, 1829) (type by typification of replaced name). Recent, Mediterranean Sea.

2009 *Williamia pliologustica* Forli et al., p. 6, figs 2C–G.

Material examined

12 spcms, in yellow sands, from Stroncoli (Bk2), average dimensions L 2 mm.

Remarks

This small species, with a large, globose protoconch, well distinct from that of the other fossil species, was originally described on specimens coming mostly from Pliocene outcrops in Liguria and one from Tuscany, Pietrafitta, San Gimignano (Siena). These gastropods inhabit lower intertidal to shallow subtidal zones but the Mediterranean *Williamia gussonii* (Costa O.G., 1829) can be found also on the *Posidonia* rhizomes.

Distribution

Early Pliocene: Bussana (Imperia), Rio S. Antonino and

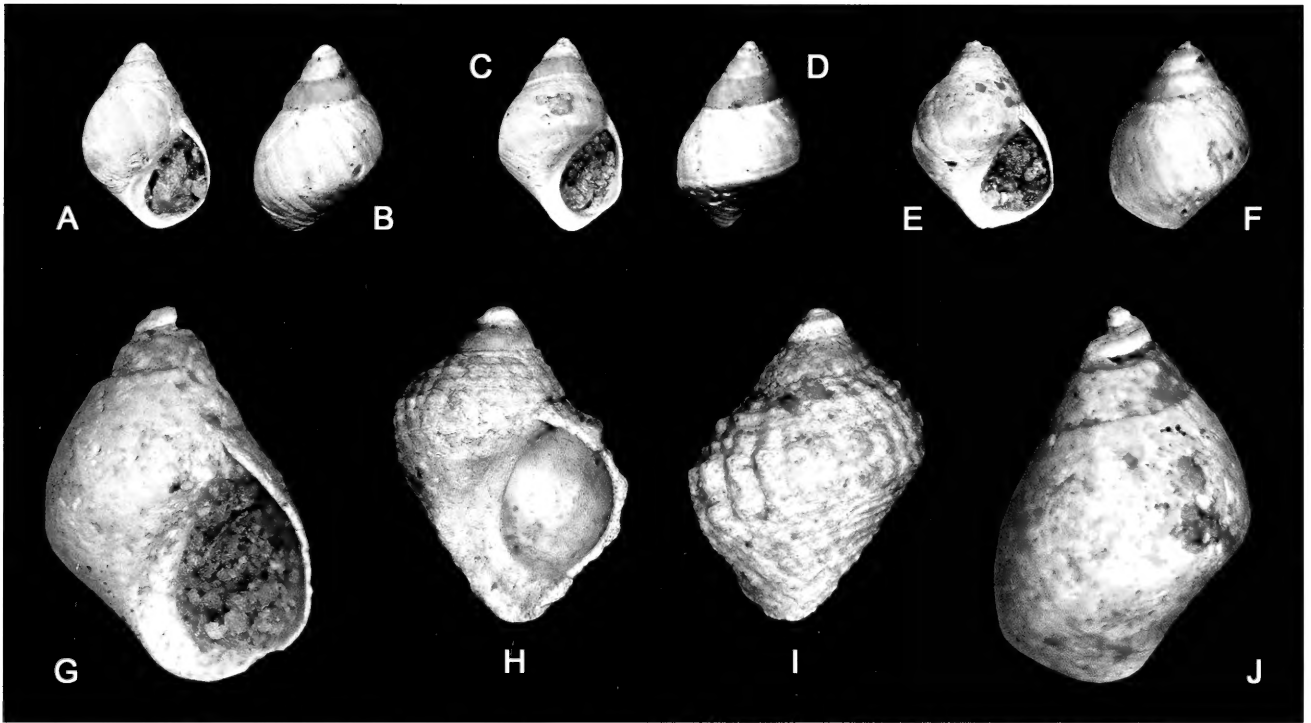


Fig. 4. A–G, *Echinolittorina ariesensis* (Fontannes, 1880) (A, B), (C, D), (E, F) H 2.5 mm each one; G, J H 5 mm. H, I *Tectarius striatus* (King & Broderip, 1832) H 4.1 mm. All the spcms are from Stroncoli (Bk2), Terre Rosse (Siena, Tuscany, Italy), Pliocene (Piacenzian).

mella edge with expanded callus, slightly concave abapically.

Remarks

This shell from Stroncoli is similar to the specimen described by Hornung (1920) as *Coralliophila pygmaea*, from the Pliocene of Rio Torsero (Savona, Liguria, Northwest Italy), that we consider a junior synonym of *T. striatus* (King & Broderip, 1832). For others comments about *T. striatus*, see Landau et al. (2004). First record for the Tuscan Pliocene.

Distribution

Italian Pliocene: Zanclean of Rio Torsero (Savona) (Hornung, 1920) and upper Pliocene (Piacenzian) of Stroncoli, Terre Rosse area (Siena) (this paper). Early Pliocene of Estepona (Spain) (Landau et al., 2004); Lower Pleistocene (Calabrian) of Ladiko, Rhodes Island (Greece) (Chirli & Linse, 2011). Present-day: Eastern Atlantic Islands [Azores, Madeira, Cape Verde Islands, Canary Islands] (Landau et al., 2004)] in high intertidal zone.

Subclass Neritimorpha Golikov & Starobogatov, 1975
Order Cycloneritimorpha Frýda, 1998
Superfamily Neritoidea Rafinesque, 1815
Family Neritidae Rafinesque, 1815
Genus *Nerita* Linnaeus, 1758

Nerita zatinii Bertarelli & Inzani, 1985
(Fig. 5. A–H)

Type species: *Nerita peloronta* Linnaeus, 1758 (type by

subsequent designation). Recent, West Indies, West Florida, Bermuda, and the Caribbean.

Nerita (*Amphinerita*?) *zatinii* Bertarelli & Inzani, 1985, p. 295, fig. 1 A–C, figs 2–5 A–C.
Nerita zatinii Bertarelli & Inzani – Chirli, 2004: p. 93, pl. 37, figs 7–15.

Material examined

30 spcms from Campino, in yellow sands (Bk1), average dimension W 13.7 mm.

Remarks

Nerita zatinii is easily distinguished from the other Tuscan Pliocene species *Nerita emiliana* Mayer, 1872 for its more oval shape and for having both the columellar callus, which has only a small tooth in the middle, and the aperture area completely smooth. More frequent in the yellow sands of Campino than in Stroncoli.

Distribution

Tuscany: Upper Pliocene (Piacenzian), Terre Rosse area, Treppió (Poggibonsi, Siena) (Bertarelli & Inzani, 1985); Cetona (Siena) (Spadini, 1986). Umbria: Pliocene, Corbara (Terni), one spcm (this paper).

Family Phenacolepadidae Pilsbry, 1895
Genus *Plesiothyreus* Cossmann, 1888

Plesiothyreus pliocenicus (Chirli, 2004)
(Fig. 6. A–C)

Type species: *Capulus parmophoroides* Cossmann, 1885

Material examined

One spcm, well preserved, H 31mm; one spcm in poor condition, H 27 mm; one basal fragment of the last whorl. All the spcms are from Stroncoli (Bk3), in yellow sands with gravel beds.

Remarks

Until now all the specimens known in the Tuscan Pliocene are from Stroncoli. The specimen reported in Chirli (2004) has a pattern very similar to the shells of living molluscs. One other similar specimen is reported by Landau et al. (2003) from the Pliocene (Piacenzian) of Velerín Conglomerates, Estepona (Spain) and by Chirli & Linse (2011) from the Pleistocene of Rhodes Island (Greece).

Distribution

Stroncoli, Terre Rosse (Siena, Tuscany, Italy), Pliocene (Piacenzian); Velerín Conglomerates, Estepona (Spain) (Landau et al., 2003). Pleistocene of the Mediterranean Sea: Rhodes Island (Greece) (Chirli & Linse, 2011). Upper Pleistocene: very common in the Marine Isotope Stage 5 (MIS 5e) (Malatesta, 1960, Ruggieri & Greco, 1965). Currently distributed in the Mediterranean Sea from Spain to Cyprus (Sousa et al., 2017) in the rocky intertidal zone.

Subclass Caenogastropoda Cox, 1960

Order Littorinimorpha Golikov & Starobogatov, 1975

Superfamily Littorinoidea Children, 1834

Family Littorinidae Children, 1834

Genus *Echinolittorina* Habe, 1956

Echinolittorina ariesensis (Fontannes, 1880)
(Fig. 4 A–G, J)

Type species: *Litorina tuberculata* Menke, 1828 accepted as *Echinolittorina tuberculata* (Menke, 1828) (type by original designation). Recent, Caribbean.

1880 *Littorina ariesensis* Fontannes, p. 177, pl. 10, fig. 10.

1895 *Melaphe ariesensis* (Font.) – Sacco: p. 15, pl. 1, fig. 27.

1992 *Littorina* (*Melaphe*) *ariesensis* (Fontannes) – Cavallo & Repetto: p. 50, fig. 67.

2004 *Echinolittorina ariesensis* (Fontannes) – Landau et al.: p. 30, pl. 4, fig. 1.

Material examined

Seven spcms, in yellow sands, from Stroncoli (Bk2), respectively one H 5 mm, three H 2.5 mm and three broken.

Remarks

Solid small shell, imperforate with conical spire. Teleoconch consists of four to five whorls, weakly convex,

separated by impressed linear sutures. Last whorl about the 70% of the total height, roundly angulate at the base; the peripheral angulation is variable, more or less prominent according to the size. Spiral sculpture consists of flattened cords separated by poorly evident grooves, probably for the slight surface abrasion. Aperture ovate with outer lip regularly convex, columellar callus expanded onto the base, slightly concave abapically. The shells retain a yellowish colour, one specimen presents on the last whorl three lighter bands (from Landau et al., 2004, modified). Terre Rosse specimens well correspond to the original diagnosis and to the description of Landau et al. (2004). For these same authors this species is very close or conspecific with the recent *Echinolittorina punctata* (Gmelin, 1791), distributed from the eastern Mediterranean to Senegal, including the Canary Islands. *E. ariesensis* likely lived in the biocenosis of the supralittoral rocks.

Surely the specimens named *Littorina* sp. by Laghi (1984) and Bertarelli & Inzani (1985) are to be assigned to this species.

Distribution

Early Pliocene: Estepona, Spain (Landau et al., 2004); Roussillon, France (Fontannes, 1880); Upper Pliocene (Piacenzian): Terre Rosse, Stroncoli, first record for the Pliocene of Tuscany. Piacenzian of Piedmont (Sacco, 1895, Cavallo & Repetto, 1992).

Genus *Tectarius* Valenciennes, 1832

Tectarius striatus (King & Broderip, 1832)
(Fig. 4. H, I)

Type species: *Tectarius coronatus* Valenciennes, 1832 (type by monotypy). Recent, (Type locality Acapulco), tropical western Pacific Ocean.

1832 *Littorina striata* King & Broderip, p. 345.

1920 *Coralliophila pygmaea* Hornung, p. 83, pl. 2, fig. 13.

2004 *Tectarius* (*Litalittorina*) *striatus* (King & Broderip) – Landau et al.: p. 31, pl. 4, figs 5–8.

2011 *Tectarius striatus* (King & Broderip) – Chirli & Linse: p. 61, pl. 14, figs 1a–e.

Material examined

One spcm from Stroncoli (Bk2), in yellow sands, H 4.1 mm.

Description

Trochoid small shell, robust, imperforate. Teleoconch of four rapidly expanding convex whorls, separated by a shallow undulate suture. Spiral sculpture consists of three rows of major tubercles, one adapically near the suture, intercalated with two smaller ones, and the others at the mid-whorl, with the major at the middle of the shell. Basal cords weak. The growth lines make the surface granulose. Last whorl about 75% of the total height, aperture oval, outer lip broken, convex. Colu-

Terre Rosse area. Recorded for the first time by Spadini (1986) this fossil population, represented by adults and young shells, varies only slightly from the Recent in being more flattened, less convex and having a different color pattern that consists in 4–5 spiral rows colored by alternating light and dark spots. Satin surface like the specimens shown here as *P. cfr mutabilis*. The variability in shell morphology from *P. richardi* and *P. mutabilis* was evidenced also by Affenzeller et al. (2017).

Distribution

Early Pliocene: western Mediterranean, Velerín Conglomerates, Estepona (Spain) (Landau et al., 2003). Upper Pliocene (Piacenzian), Terre Rosse (Siena, Tuscany, Italy). Upper Pleistocene, Marine Isotope Stage 5 (MIS 5e)

(Malatesta, 1960, Ruggieri & Greco, 1965). Present-day: Mediterranean Sea, from Spain to Croatia (Sousa et al., 2017), prevalently on rocky shore. The young specimens are frequent in pebbly bottom near the low tide level. Intertidal up to 20 m depth.

Phorcus turbinatus (Born, 1778) (Fig. 3. M–O)

- 1780 *Trochus turbinatus* Born, p. 340.
- 2003a *Monodonta turbinata* (Born) – Forli et al.: p. 139, figs 2–3.
- 2003 *Phorcus turbinatus* (Von Born) – Landau et al.: p. 52, pl. 12, fig. 1.
- 2004 *Monodonta turbinata* (Von Born) – Chirli, p. 76, pl. 32, figs 1–4.
- 2011 *Monodonta turbinata* (Von Born) – Chirli & Linse: p. 47, pl. 9, figs 1a–d.

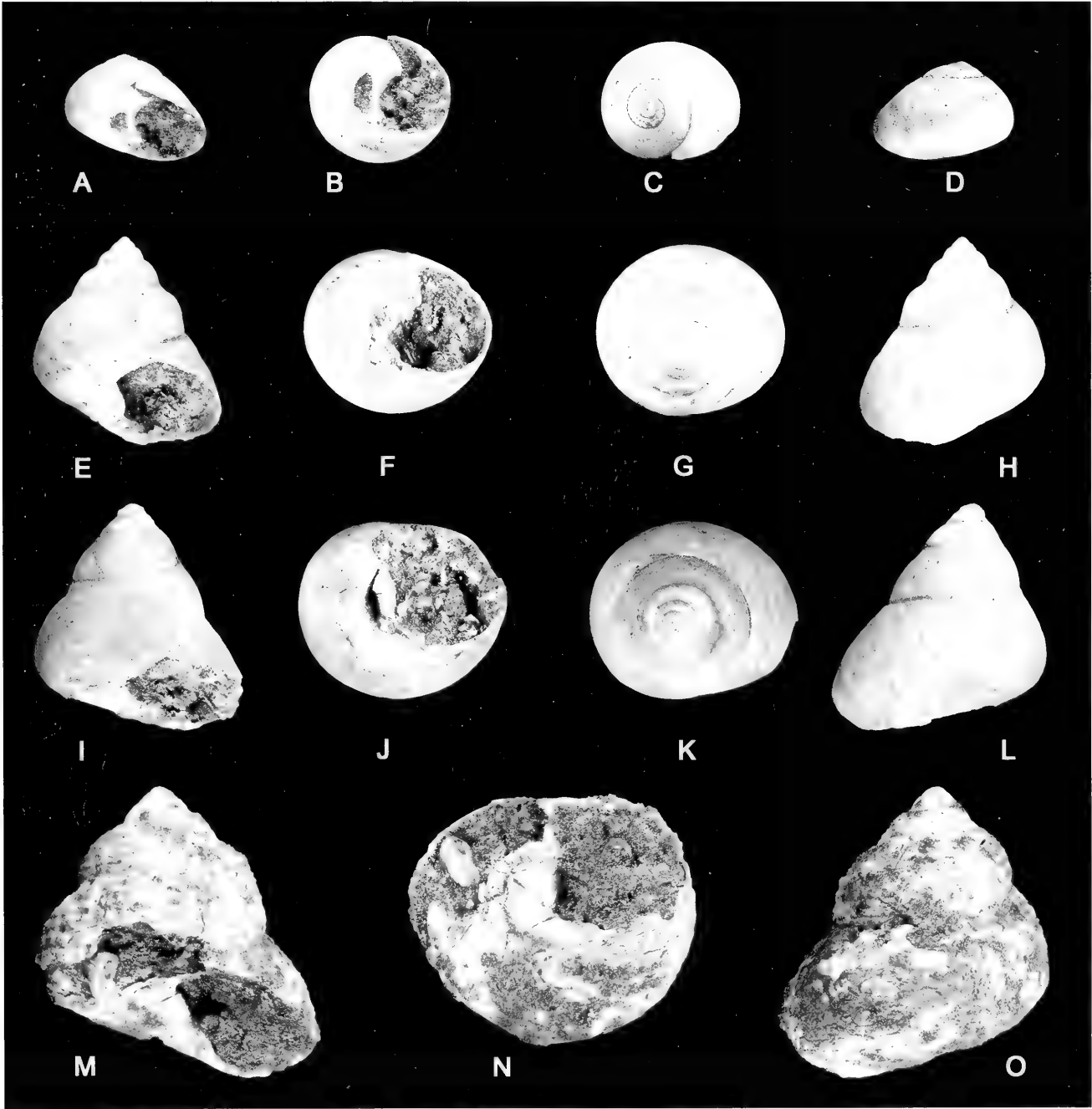


Fig. 3. A–D *Phorcus richardi* (Payraudeau, 1826), D 15 mm (Bk2); E–L *Phorcus cfr. mutabilis* (Philippi, 1851) (E–H) H 22 mm (Bk3); (I–L) H 24 mm (Bk3); M–O *Phorcus turbinatus* (Born, 1778), H 31 mm (Bk3). All the spcms are from Stroncoli, Terre Rosse (Siena, Tuscany, Italy), Pliocene (Piacenzian).

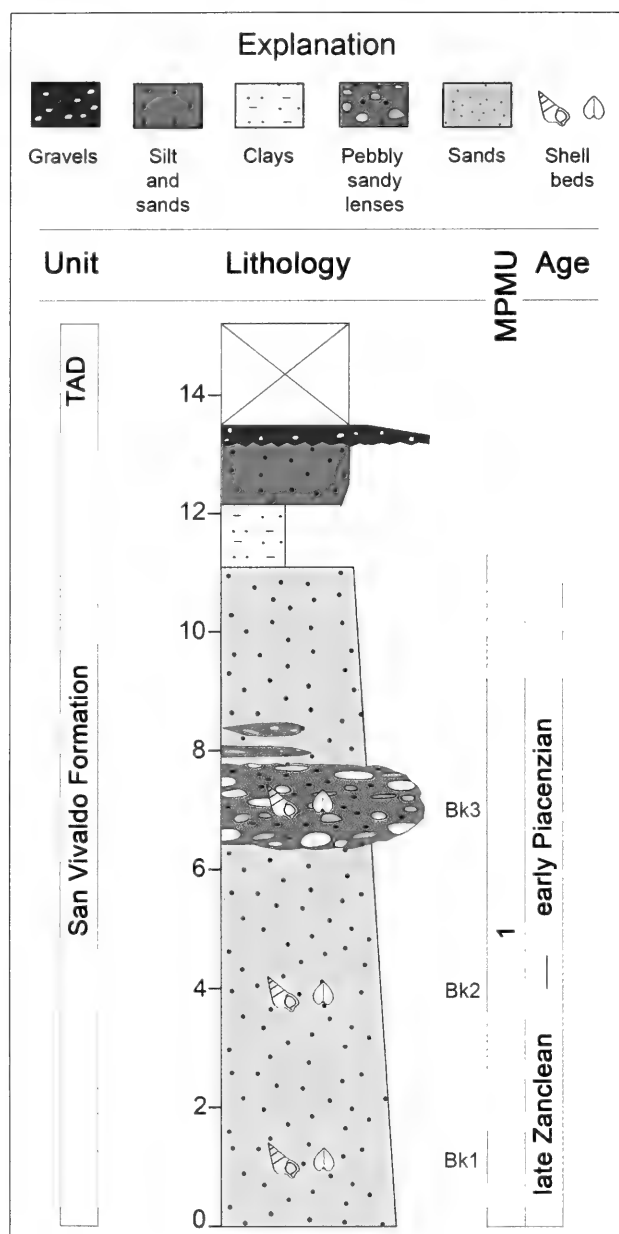


Fig. 2. Simplified stratigraphic log of the fossiliferous Terre Rosse area, between Campino and Stroncoli. Pliocene, late Zanclean – early Piacenzian, MPMU1 interval. Bulk sample: **Bk1**, **Bk2** [respectively to the bulk sample 1 and 2, 3, in Naldi et al. (2013)], **Bk3** [the same pebbly-sandy lens reported in Forlì et al. (2003b, 2004)]. **TAD** Terraced alluvial deposits: early Pleistocene to Recent. [from Forlì et al., 2003b, 2004 and Naldi et al., 2013, both modified].

Material examined

Two spcms from Stroncoli (Bk3), in yellow sands with thin gravel beds, H 24 mm, H 22 mm.

Remarks

These herbivorous gastropods live on rocky substrates from the upper to the lower tide levels. They are currently represented by nine living species with a clear separation between those occurring in the Atlantic and in the Mediterranean. Four species are restricted to the Mediterranean Sea, *Porchus articulatus* (Lamarck, 1822), *P. mutabilis* (Philippi, 1851), *P. richardi*

(Payraudeau, 1826) and *P. turbinatus* (Born, 1778) and the others species occur in the Northeastern Atlantic Ocean. Concerning the geographic distribution of the genus in the Mediterranean Sea, *P. articulatus* occurs from Spain to Tunisia, *P. mutabilis* from Italy to Turkey, *P. richardi* from Spain to Croatia, *P. turbinatus* from Spain to Cyprus (Sousa et al., 2017). This specimen is the second found in these outcrops in almost twenty years (Forlì et al., 2003a). Previously classified as *Monodonta articulata*, we tentatively compare these two specimens to the Recent *P. mutabilis*, from which they differ for their smooth surface, the presence of a distinct, narrow and shallow umbilicus, a columella with a somehow undefined bulge and a different color pattern. This consists, on the last whorl, of small variable dark-brown spots arranged in 11–12 spiral rows with a slight offset from one row to the next, similar to that of the specimens of *P. richardi* found in the same area. The Recent *P. mutabilis* has been given conchological traits similar to those of *P. richardi* (Payraudeau, 1826) (e.g., Ghisotti & Melone, 1975). These two taxa, now enclosed in the same genus, have been however clearly differentiated (Gofas & Jabaud, 1997). The Pliocene species have a different aspect than Recent congeners. Other similar Pliocene species are reported by Sacco, 1896 *Trochocochlea turbinata* var. *pliocenica* (p. 24, pl. 3, fig. 10) and *Trochocochlea articulata* (Lamarck, 1822), Cavallo & Repetto, 1992 (p. 40, fig. 35) from Piedmont (Italy) and by Landau et al. (2003: p. 53, pl. 11, fig. 6) from Estepona and from the lower Pliocene of the Huelva Sands Formation (Spain) (Landau et al. 2011: pp. 8–9, pl. 1 figs 9–10).

Distribution

Terre Rosse, Stroncoli (Siena, Tuscany, Italy), Pliocene (Piacenzian). *Phorcus mutabilis* (Philippi, 1851) is reported for the lower Pleistocene of Romagna Apennine (Italy) (Sami & Taviani, 1997). Currently distributed in the Mediterranean Sea from Italy to Turkey, on hard substrates from the intertidal zone.

Phorcus richardi (Payraudeau, 1826) (Fig. 3. A–D)

1826 *Monodonta richardi* Payraudeau, p. 138, pl. 7, figs 1–2.

1986 *Gibbula* (*Phorcus*) *richardi* (Payraudeau) – Spadini: p. 87, pl. 1, figs 5–6.

2003 *Phorcus richardi* (Payraudeau) – Landau et al.: p. 51, pl. 11, fig. 2.

2004 *Gibbula* (*Phorcus*) *richardi* (Payraudeau) – Chirli: p. 73, pls 29–30, figs 11–12/1–3.

Material examined

22 spcms, in yellow sands, from Terre Rosse area, (Bk1, Bk2); D, average dimension 12 mm.

Remarks

This taxon is the most common *Phorcus* present in the

the overall uplift of southern Tuscany that finally led to subaerial exposure during the Pleistocene (Martini & Aldinucci, 2017). In the Terre Rosse area, Pliocene deposits are mainly indicative of marine environments and are represented by nearshore sands and conglomerates which pass basinward to offshore muds. These can be tentatively referred to depositional sequences S3 and S4 (in part) described in the literature (Martini & Aldinucci, 2017).

The studied specimens were collected at the outcrops, referred to here as localities Campino and Stroncoli (Fig. 1), where the lower yellow sands and yellow sands rich in pebbly-sandy lenses crop out. Sampled shell beds are located in the stratigraphic section described by Naldi et al. (2013), integrated with other previous observations (Forli et al., 2003b, 2004), allowing to refer the Terre Rosse succession to the San Vivaldo Formation (Naldi et al., 2013) (Fig. 2). The corresponding levels can be compared with those of Naldi et al. (2013) and Forli et al. (2003b, 2004) and are reported in the stratigraphic section. Samples Bk1 and Bk2 of the present study likely correspond respectively to bulk samples 1 + 2 and 3 of Naldi et al. (2013). Sample Bk3 was collected instead in the pebbly-sandy lens reported by Forli et al. (2003b, 2004). This particular deposit has proved to be of exceptional value in supplying fossil mollusc shells from littoral environments, including forms typical of the intertidal zone, only rarely encountered as fossils, including species of Haliotidae and Patelidae first described by Forli et al. (2003b, 2004).

The marine Pliocene section is ~11 m thick and consists in its lower half of sands alternated with gravelly units. This part is richly fossiliferous with numerous shell beds in the upper-middle part and dated from upper Zanclean to Piacenzian. The upper part of the succession is a terraced alluvial deposit of Pleistocene–Recent age (TAD in Naldi et al., 2013). The concomitant occurrence of stenothermal gastropods of families Trochidae (Spadini, 1986; 1987a–b), Strombidae, Conidae, (Spadini, 1990) and Terebridae, accompanied by bivalves that did not overcome the first climatic crisis occurred in the Piacenzian [e.g., *Codakia leonina* (Basterot, 1825), *Arcopa-*

gia sedgwicki (Michelotti, 1839), *Gari labordei* (Basterot, 1825), *Pelecypora gigas* (Lamarck, 1818)], allow to refer the Terre Rosse malacological association to an age preceding the climatic deterioration of 3 Ma. In other words, they belong to the MPMU1 interval of the upper Neogene stratigraphic subdivision based on molluscs (Monegatti & Raffi, 2001).

Material and methods

Twenty bulk samples, about 5 kg each, were collected in localities Campino and Stroncoli in surface exposures of Pliocene fossiliferous deposits. The sediments were disaggregated with hydrogen peroxide and water and dried. Then they were sieved and dried and the various fractions sorted out for the shells under a stereo microscope (x20). Suprageneric systematics follows the World Register of Marine Species (WoRMS, 2021). Acronyms and abbreviation: Bulk sample = Bk; H = height; L = length; W = width; D = diameter; spcm/spcms = specimen/specimens.

Systematics

Class Gastropoda Cuvier, 1795
 Subclass Vetigastropoda Salvini-Plawen, 1980
 Order Trochida [unassigned]
 Superfamily Trochoidea Rafinesque, 1815
 Family Trochidae Rafinesque, 1815
 Genus *Phorcus* Risso, 1826

Phorcus cfr. *mutabilis* (Philippi, 1851)
 (Fig. 3. E–L)

Type species: *Phorcus margaritaceus* Risso, 1826 accepted as *Phorcus richardi* (Payraudeau, 1826) (type by subsequent designation). Recent, Mediterranean Sea.

1851 *Trochus mutabilis* Philippi, p. 166, pl. 26, figs 18–22.
 2003a *Monodonta articulata* Lamarck – Forli et al.: p. 139, figs 7–8.

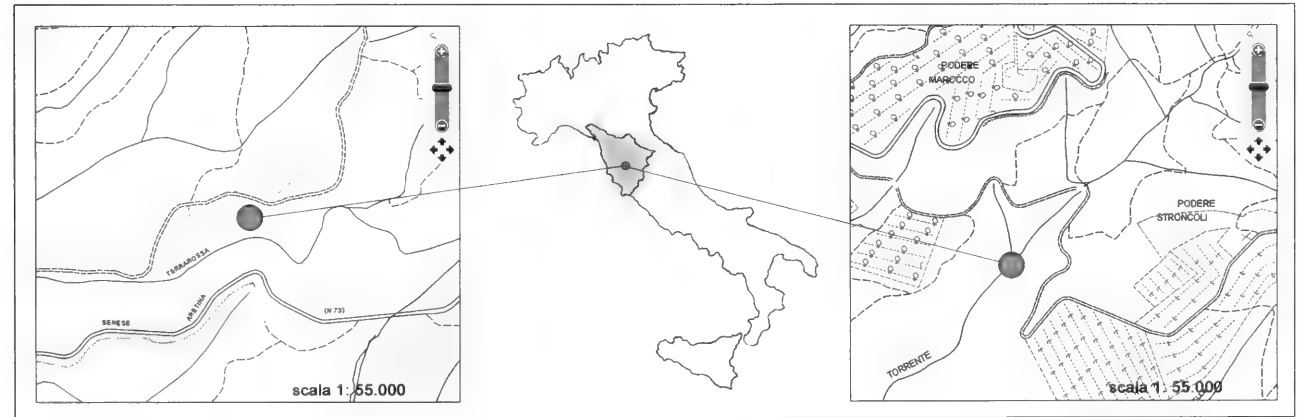


Fig. 1. On the left locality Campino (43°20'17,6" N, 11°34'46,3" E) and, on the right, Stroncoli H (43°19'59,4" N, 11°35'42,8" E). These are the outcrops richest in fossil shell beds among the Pliocene of the Terre Rosse area (about 6 km east of Castelnuovo Berardenga, Siena). Topographic map from <https://castelnuovobga.ldpgis.it>, scale 1:55.000.

Intertidal rocky shore Gastropoda (Mollusca) from the Pliocene of Terre Rosse (Siena)

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Abstract

This paper reports on some Pliocene gastropods characteristic of intertidal rocky marine environments collected in a small area of the Siena Basin known in the fossil malacological literature as Terre Rosse, near Castelnuovo Berardenga. Pliocene deposits of the area (late Zanclean – early Piacenzian) are mainly indicative of marine environments and are represented by nearshore sands and conglomerates which pass basinward to offshore muds. We report the species *Echinolittorina ariesensis* (Fontannes, 1880), *Tectarius striatus* (King & Broderip, 1832), *Plesiothyreus pliogenicus* (Chirli, 2004), *Williamia pliologustica* Forli et al., 2009 and *Trimusculus mammillaris* (Linnaeus, 1758). This is the first report of these rare species, as is the case of fossils from rocky marine environments, for an area that is otherwise well known for its rich molluscan fauna.

Key Words

Intertidal rocky shore, Gastropods, Terre Rosse, Pliocene, Tuscany.

Riassunto

In genere è insolito trovare ambienti geologicamente rappresentativi di habitat sublitorali con fondo roccioso, dove la fossilizzazione è un evento raro. L'area delle Terre Rosse, nei pressi di Castelnuovo Berardenga (Siena), si caratterizza per la presenza di depositi marini pliocenici, alternanze di livelli di sabbie e ghiaie più o meno potenti, riferibili per la maggior parte ad ambienti dell'infra-litorale. Nelle tanatocenosi autoctone a molluschi si rinvenivano raramente anche resti alloctoni accidentali riferibili alla zona sopra e mediolitorale (intertidale) di ambiente roccioso. Com'è noto la zona intertidale è un ecosistema marino popolato da una moltitudine di organismi adattati a vivere ai cambiamenti che sopraggiungono tra l'alta e la bassa marea. Lo scopo di questa nota è proprio quello di evidenziare i ritrovamenti dei gasteropodi legati alle biocenosi dei substrati rocciosi, riferibili direttamente a questo ambiente o ad esso strettamente correlate. Si segnalano pertanto i nuovi ritrovamenti di *Echinolittorina ariesensis* (Fontannes, 1880), *Tectarius striatus* (King & Broderip, 1832), *Plesiothyreus pliogenicus* (Chirli, 2004), *Williamia pliologustica* Forli, et al., 2009 e *Trimusculus mammillaris* (Linnaeus, 1758) discussi insieme a *Chiton saeniensis* Laghi, 1984, *Patella alessiae* Forli, Dell'Angelo, Montagna & Taviani, 2004, *Patella caerulea* Linnaeus, 1758, *Haliotis* spp., *Phorcus* cfr *mutabilis* (Philippi, 1851), *Phorcus richardi* (Payraudeau, 1826), *Phorcus turbinatus* (Born, 1778), *Nerita zatinii* Bertarelli & Inzani, 1985.

Parole chiave

Habitat sublitorali rocciosi, Gastropodi, Terre Rosse, Pliocene, Toscana.

Introduction

It is generally uncommon to find environments that are geologically representative of rocky– bottom sublittoral habitats, where fossilization is a rare occurrence. In this paper, we report on some intertidal fossil gastropods rare or absent in other Pliocene Tuscan localities. The specimens are found in a restricted area of the Pliocene Siena basin informally known as Terre Rosse. In this locality there are nearshore sands and conglomerates, rich in fossil shells, with assemblages clearly dominated by species indicating very shallow, infralittoral–sublittoral provenances, as proven by the occurrence of Chitonidae, Patellidae, Haliotidae, Trochidae, Neritidae, where occasionally is possible to find gastropods exclusive of the rocky intertidal zone, the area within the tidal range. Some of these species have been previously established, e.g., *Chiton saeniensis* Laghi, 1985, *Patella*

alessiae Forli et al., 2004, *Haliotis bertinii* Forli et al., 2003b, *Gibbula terrerossae* Spadini, 1986, *Nerita zatinii* Bertarelli & Inzani, 1985, or reported (Dell'angelo & Forli, 1995; Chirli, 2000, 2004), others new for this area, are here recorded: *Echinolittorina ariesensis* (Fontannes, 1880), *Tectarius striatus* (King & Broderip, 1832), *Plesiothyreus pliogenicus* (Chirli, 2004), *Williamia pliologustica* Forli, et al., 2009 and *Trimusculus mammillaris* (Linnaeus, 1758).

Geological setting

Terre Rosse is an area located about 6 km east of Castelnuovo Berardenga (Siena), in the Pliocene Siena Basin (Tuscany, central Italy). The Pliocene of the Siena Basin is up to 600 m thick and includes Zanclean and Piacenzian deposits (Martini & Aldinucci, 2017). The succession is overlain by regressive deposits deposited during

- Estepona, Parte I. Mollusca, Gastropoda. Descripción de nuevas especies del Plioceno de las Cuenca de Estepona (Malaga) y del Guadalquivir (Huelva). *Pliocenica*, 5:105–124.
- LOZOUET P., 2017. Les Conoidea de l'Oligocène supérieur (Chattien) du bassin de l'Adour (Sud-Ouest de la France). *Cossmanniana*, 19: 3–180.
- MARQUINA M. J., 1988. *Clavatula acuticostulata* n. sp.: propuesta de una nueva especie de Turridae (Gastropoda) para el Plioceno mediterraneo. *Iberus*, 8(1): 1–6.
- MAYER-EYMAR C., 1891. Description de coquilles fossiles des étages supérieurs des terrains tertiaires. *Journal de Conchyliologie*, 39: 317–344.
- MONEGATTI P. & RAFFI S., 2001. Taxonomic diversity and stratigraphic distribution of Mediterranean Pliocene bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 165: 171–193.
- PACAUD J. M. & LE RENARD J., 1995. Révision des Mollusques paléogènes du Bassin de Paris. IV - Liste systématique actualisée. *Cossmanniana*, 3 (4): 151–187.
- POWELL A. W. B., 1966. The molluscan families Speightiidae and Turridae: an evaluation of the valid taxa, both recent and fossil, with lists of characteristic species. *Bulletin of the Auckland Institute and Museum*, 5: 1–184.
- SCARPONI D. & DELLA BELLA G., 2004. *Molluschi Marini del Plio-Pleistocene dell'Emilia-Romagna e della Toscana. Superfamiglia Conoidea. Vol. 1 - Drillidae e Turridae*. 94 pp. Regione Emilia-Romagna, Bologna.
- VERA-PELÁEZ J. L., 2002. Revisión de la familia Turridae, excepto Clavatulinae (Gastropoda, Prosobranchia) en el Plioceno de la cuenca de Estepona, Málaga y Vélez-Málaga (Málaga, S España) con la descripción de 26 especies nuevas. *Pliocenica*, 2: 176–262.
- VERA-PELÁEZ J. L. & BATLORI AGUILÀ J., 1996. Le subfamiglia Crassispirinae Morrison, 1966 (Turridae, Gastropoda) del Neógeno de la Peninsula Ibérica. *Malakos*, 5: 35–52.
- VERA-PELÁEZ J. L. & LOZANO-FRANCISCO M. C., 2004. La colección de escafópodos pliocénicos (Mollusca, Scaphopoda) del Museo Municipal Paleontológico de Estepona (Málaga, España) con la descripción de tres nuevas especies. *Pliocenica*, 4: 51–94.
- VERA-PELÁEZ J. L., LOZANO-FRANCISCO M. C., RAMOS FERNÁNDEZ J. & CORTÉS SÁNCHEZ M., 2004. Moluscos del Tirreniense (Pleistoceno Superior) de la Playa la Araña-Cala del Moral (Málaga). [Molluscs from Tyrrhenian (Upper Pleistocene) of the Beach of Araña-Cala del Moral (Málaga).] *Revista Española de Paleontología*, 19 (2): 251–259.
- VERA-PELÁEZ J. L., LOZANO-FRANCISCO M. C., MUÑIZ-SOLÍS R., GILI C., MARTINELL J., DOMÈNECH R., PALMQVIST P. & GUERRA-MERCHÁN A., 1995. Estudio preliminar de la malacofauna del Plioceno de Estepona (Málaga, España). *Iberus*, 13 (2): 93–117.
- VERA-PELÁEZ J. L. & MUÑIZ-SOLÍS R., 1995a. Nueva especie de la subfamilia Admetulinae (Cancellariidae, Gastropoda) del Plioceno de Estepona (Málaga, España). *Revista Española de Paleontología*, 10(2): 297–301.
- VERA-PELÁEZ J. L., MUÑIZ-SOLÍS R., LOZANO-FRANCISCO M. C., MARTINELL J., DOMÈNECH R. & GUERRA-MERCHÁN A., 1995b. Cancellariidae Gray, 1853 del Plioceno de la provincia de Málaga, España. *Treballas de Museu Geològic de Barcelona*, 4: 133–179.
- WORMS EDITORIAL BOARD, 2021. World Register of Marine Species. Available from <http://www.marinespecies.org> at VLIZ. Accessed 2021-04-15. doi:10.14284/170.

- J. L. & SILVA C. M. DA, 2006. Integrated biochronology of the Pliocene deposits of the Estepona Basin (Málaga, S Spain). Palaeobiogeographic and palaeoceanographic implications. *Revista Española de Paleontología*, **20**: 225–244.
- BENVENUTI M., DEL CONTE S., SCARSELLI N. & DOMINICI S., 2014. Hinterland basin development and infilling through tectonic and eustatic processes: latest Messinian-Gelasian-Valdelsa Basin, Northern Apennines, Italy. *Basin Research*, **26**: 387–402. doi: 10.1111/bre.12031
- BOUCHET P., KANTOR YU I., SYSOEV A. & PUILLANDRE N., 2011. New operational classification of the Conoidea (Gastropoda). *Journal of Molluscan Studies*, **77**: 273–308.
- BRUGNONE G., 1876. Due specie fossili nuove di Altavilla. *Bollettino della Società Malacologica Italiana*, **2**(1): 216–218.
- BRUNETTI M., 2014. *Conchiglie fossili di Monte Antico*. Tipolito Duemila Group, Campi Bisenzio (FI), 118 pp.
- BRUNETTI M., 2016. On some Pliocene Cancellariidae (Mollusca Gastropoda) from the Mediterranean Basin with description of a new species. *Biodiversity Journal*, **7**(3): 319–324.
- BRUNETTI M., 2020. On the taxonomic validity of *Lissochlamys perstriatula* (Sacco, 1897) (Bivalvia Pectinidae). *Biodiversity Journal*, **11**(1): 3–6.
- BRUNETTI M., 2020a. On two rare species of Plio-Pleistocene marine molluscs of the Mediterranean Basin. *Biodiversity Journal*, **11**(4): 897–902.
- BRUNETTI M. & DELLA BELLA G., 2014. La famiglia Buccinidae Rafinesque, 1815 nel Plio-Pleistocene italiano: i generi *Aplus* De Gregorio, 1884, *Engina* Gray, 1839 e *Gemophos* Olsson & Harbison, 1953 (Gastropoda). *Bollettino Malacologico*, **50**(1): 11–32.
- BRUNETTI M. & DELLA BELLA G., 2016. Revisioni di alcuni generi della famiglia Buccinidae Rafinesque, 1815 nel Plio-Pleistocene del Bacino mediterraneo, con descrizione di tre nuove specie. *Bollettino Malacologico*, **52**(1): 3–37.
- BRUNETTI M., DELLA BELLA G., FORLÌ M. & VECCHI G., 2008. La famiglia Cancellariidae Gray J.E., 1853 nel Pliocene italiano: note sui generi *Scalptia* Jousseume, 1887, *Tribia* Jousseume, 1887, *Contortia* Sacco, 1894, *Trigonostoma* Blainville, 1827 e *Aneurystoma* Cossmann, 1899 (Gastropoda), con descrizione di una nuova specie. *Bollettino Malacologico*, **44** (5-8): 51–70.
- BRUNETTI M., DELLA BELLA G., FORLÌ M. & VECCHI G., 2009. La famiglia Cancellariidae Forbes & Hanley, 1851 (Gastropoda) nel Plio-Pleistocene italiano: i generi *Bonellitia*, *Pseudobabynella* n. gen., *Admete* e *Cancellicula* Tabanelli, 2008, con descrizione di tre nuove specie. *Bollettino Malacologico*, **45**: 55–81.
- BRUNETTI M., FORLÌ M. & VECCHI G., 2006. La Famiglia Cancellariidae Gray J. E., 1853 nel Plio-Pleistocene mediterraneo. I generi *Tribia* Jousseume, 1887 e *Scalptia* Jousseume, 1887 con descrizione di due nuove specie. *Bollettino Malacologico*, **42** (5-8): 39–57.
- CAPEZZUOLI E., FORESI L. M., SALVATORINI G. & SANDRELLI F., 2005. New data on the Middle Pliocene sedimentation in the southern Valdelsa Basin (Siena, Italy). *Bollettino della Società geologica Italiana*, Special Issue, **4**: 95–103.
- DE STEFANI C. & PANTANELLI D., 1878. Molluschi pliocenici dei dintorni di Siena. *Bollettino della Società Malacologica Italiana*, **4**(1–30): 1–215.
- DOMINICI S., DANISE S., BENVENUTI M., 2018. Pliocene stratigraphic paleobiology in Tuscany and the fossil record of marine megafauna. *Earth Science Reviews*, **176**: 277–310.
- DOMINICI S., BENVENUTI M., GARILLI V., UCHMAN A., POLLINA F. & DAVID A., 2020. Pliocene-Pleistocene stratigraphic paleobiology at Altavilla Milicia (Palermo, Sicily): tectonic, climatic and eustatic forcing. *Bollettino della Società Paleontologica Italiana*, **59**(1): 57–83.
- DOMINICI S. & FORLÌ M., 2021. Lower Pliocene molluscs from southern Tuscany (Italy). *Bollettino della Società Paleontologica Italiana*, **60**: 69–98.
- FORESTI L., 1897. Sopra alcuni fossili raccolti nei colli fiancheggianti il fiume Santerno sulle vicinanze di Imola. *Bollettino della Società Geologica Italiana*, **16**: 201–241.
- LANDAU B., 1984. A discussion of the Mollusca Fauna of two Localities in the Province of Huelva (Spain), including description of six new species. *Tertiary Research*, **6**(4): 135–155.
- LANDAU B., BEU A. & MARQUET R., 2004. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 5. *Palaeontos*, **5**: 35–102.
- LANDAU B. & SILVA C. M. DA, 2006. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 9: Olividae. *Palaeontos*, **9**: 1–21.
- LANDAU B., SILVA C. M. DA & GILI C., 2009. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 8: Nassariidae. *Palaeontos*, **17**: 1–101.
- LANDAU B., SILVA C. M. DA & MAYORAL E., 2011. The Lower Pliocene gastropods of the Huelva Sands Formation, Guadalquivir Basin, Southwestern Spain. *Palaeofocus*, **4**: 1–90.
- LANDAU B. & FESHE D., 2004a. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 3. Trivioidea, Cypraeoidea. *Palaeontos*, **5**: 1–34.
- LANDAU B., HOUART R. & MARQUET R., 2007. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 7: Muricidae. *Palaeontos*, **11**: 1–87.
- LANDAU B., JANSEN A. & SILVA C. M. DA, 2015. Additions to the gastropod assemblage of the Pliocene of Estepona, southwestern Spain, 2. The genus *Spiricella* Rang, 1828 (Umbraculida; Umbraculidae). *Basteria*, **79** (1–3): 55–58.
- LANDAU B., LA PERNA R. & MARQUET R., 2006a. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 10: Marginellidae, Cystiscidae. *Palaeontos*, **9**: 22–60.
- LANDAU B., LA PERNA R. & MARQUET R., 2006b. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 6: Triphoroidea, Epitonioidae, Eulimoidea. *Palaeontos*, **10**: 1–96.
- LANDAU B. & MARQUET R., 2000. The genus *Cymbium* (Gastropoda, Volutidae) in the Iberian Neogene. *Contribution to Tertiary and Quaternary Geology*, **37**(1): 23–24.
- LANDAU B., MARQUET R. & GRIGIS M., 2003. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 1. Vetigastropoda. *Palaeontos*, **3**: 1–87.
- LANDAU B., MARQUET R. & GRIGIS M., 2004b. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 2. Orthogastropoda, Neotaenioglossa. *Palaeontos*, **4**: 1–108.
- LANDAU B., PETIT R. & MARQUET R., 2006c. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain. Part 12: Cancellarioidea. *Palaeontos*, **9**: 61–101.
- LA PERNA R., BRUNETTI M. & DELLA BELLA G., 2018. Systematic position of two Pliocene carditids with description of *Akardita* n. gen. and *A. iberica* n. sp. (Bivalvia: Carditidae). *Zootaxa*, **4379** (2): 215–230.
- LOZANO-FRANCISCO M. C. & LANDAU B., 1999. New species of the bivalve genera *Donax* and *Callista* from the lower Pliocene of Huelva, Spain. *Contribution to Tertiary and Quaternary Geology*, **36** (1-4): 9–23.
- LOZANO-FRANCISCO M. C. & VERA-PELÁEZ J. L., 2002. Estudio preliminar del Orden Archeogastropoda (Gastropoda, Prosobranchia) del Plioceno de la cuenca de Estepona (Málaga, S. España) con la descripción de doce especies nuevas. *Pliocenica*, **2**: 157–175.
- LOZANO-FRANCISCO M. C. & VERA-PELÁEZ J. L., 2006. Catálogo del Material tipo del Museo Municipal Paleontológico de

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Appendix

Italian description of the new species/Descrizioni delle nuove specie:

Crassispira pseudoglabra n. sp. - Conchiglia di dimensioni medio-piccole (H massima 16 mm). La spira è stretta, con angolo spirale di circa 35 gradi, di forma claviforme allungata. Protoconca paucispirale papilliforme, di 1,5 giri, priva di scultura. Il passaggio protoconca teleoconca è segnato dall'apparire di una robusta costa. Teleoconca di circa sette giri, leggermente scalariati, con suture poco profonde, ondulate. Piega sub-suturale evidente. Scultura assiale composta da coste robuste, nodose, più larghe degli interspazi, 6-7 nei primi due giri, 11-12 sul penultimo. Scultura spirale molto sottile ma presente su tutti i giri, costituita da numerosi filetti della stessa larghezza, una quindicina sul penultimo giro, presente anche nella fasciola anale che è larga e appiattita. Nell'ultimo giro, che misura circa i 3/5 dell'altezza totale, le coste assiali continuano su quasi tutto il giro, obliterandosi abapicalmente mentre la scultura spirale diviene più evidente. Apertura stretta e allungata, labbro esterno sottile, callo parietale robusto, seno anale a forma di U, poco profondo. Callo columellare robusto, seno inalante ampio, corto (Fig. 1 A-H).

Crassispira plioibericostricta n. sp. - Conchiglia di dimensioni medio-piccole (H massima 19 mm). La spira è stretta, con angolo spirale di circa 30 gradi, di forma claviforme allungata, con giri leggermente convessi. Protoconca multispirale di 3 giri priva di scultura. Il passaggio protoconca teleoconca è segnato dall'apparire di una costa ortocline poco evidente. Teleoconca di circa sei giri, con suture poco profonde. Piega sub-suturale debole, poco evidente. Scultura assiale composta da coste sottili, leggermente nodose, più strette degli interspazi, 6-7 nei primi due giri leggermente ortocline, più numerose e decisamente opistocline nei giri successivi tendenti a sparire sull'ultimo giro. Scultura spirale assente tranne nella fasciola anale che è appiattita con ornamentazione costituita da numerosi filetti spirali sottilissimi, visibili solo a forte ingrandimento che si incrociano con le linee di accrescimento. Nell'ultimo giro, che misura circa la metà dell'altezza totale, le coste assiali si obliterano, mentre si evidenzia una sottilissima scultura spirale incrociata alle linee di accrescimento. Apertura stretta e allungata, labbro esterno sottile, seno anale ampio e poco profondo. Callo columellare sottile, seno inalante ampio, corto (Fig. 2 A-O).

Original description of the other species discussed/Descrizioni originali delle altre specie trattate:

Crassispira pseudosigma (Brugnone, 1876) - *Pleurotoma* (*Drillia*) *pseudosigma* (Tav. C, fig. 4). Descrizione Originale: Pl. testa turrita, elongata, transversim tenuissime striata:

anfractibus 9-10, subconvexis, longitudinaliter costato-nodosis: costis 6-7, elevatis, abruptis, obliquis, interstitiis multo minoribus: suturis superioribus marginatis, undulatis: apertura angusta: canali brevi, latiusculo: labro dextro simplici, acuto: sinistro tenui, adnato: sinu profundo. Long. mm. 19. - Lat. mm. 6. (Fig. 3, D-E).

Crassispira torcapeli (Mayer-Eymar, 1891) - Original description: Testa claviformi, crassula, spira longiuscula, acuta; anfractibus circiter 10, convexiusculis, latiusculis, medio angulatis, sutura angusta profunda separalis, postice margine crasso, obtuse nodoso, instructis, anticem et ad suturam posticam transverse striatis; costis longitudinalibus 9 in anfractu, brevibus, rectis, distantibus, in angulo leviter spinosis, in canalem rimae evanescentibus; ultimo anfractu spiram aequante, antice velociter depresso, in caudam brevem, latam, obliquam, transverse striatam, exeunte, costis longitudinalibus usque, ad caudae initium productis, attenuatis antem et plerumque bifidis striisque transversis sensim majoribus et distantioribus clathrato-granoso; oreovato-oblongo, in canalem brevem et latam exeunte; columella fere recta; rima profunda, acutiuscula. - long. 28, lat. 11 millim. (Fig. 4 E, H).

Crassispira minor (Foresti, 1897) - Descrizione Originale: È un piccolo esemplare che riproduce perfettamente tutti quanti i caratteri assegnati alla specie tipo, tranne delle dimensioni e della forma dell'orlo presso la sutura. È di forma turrita, di spira lunga; gli anfratti sono quasi piani alla parte posteriore, leggermente canalicolati e marginati; il canaletto proporzionalmente largo è poco profondo, ed occupa quasi la porzione mediana degli anfratti, però un poco più vicino alla sutura posteriore; le suture sottili, ma ben distinte, e l'orlo anteriore che le accompagna non molto grosso, nè molto prominente; presenta come la specie tipo delle strie trasversali, minute, ondulate nella parte anteriore degli anfratti, lasciando liscia la parte posteriore; così pure mostra lo stesso numero e la stessa forma di coste longitudinali, e finalmente nessuna differenza, tranne sempre delle dimensioni, nella forma dell'apertura, delle labbra, della columella. Per la forma e le dimensioni, molto somiglia alla *D. fratercula* Bell., ma il numero delle coste, la loro sporgenza su tutti gli anfratti, e le strie trasversali più grandi e più impresse, la fanno distinguere; inoltre questa specie del Bellardi non è stata raccolta, secondo l'autore, che nel solo miocene medio. Anche la *D. terebra* (Bast.) presenterebbe molta somiglianza coll'esemplare in esame, per le dimensioni e la forma, ma il margine suturale grosso, prominente, irregolarmente nodoso, il maggior numero delle coste longitudinali che terminano con una specie di nodosità presso la sutura e che si prolungano anche lungo la coda, ne fanno subito palese la differenza. Anche questa specie del Basterot, il Bellardi la dice rarissima e raccolta solamente nel miocene medio. L'esemplare dell'Imolese misura 22 millim. di diametro longitudinale 9 millim. di diametro trasversale. Croara. (Fig. 5 B-F).

References

AGUIRRE J., CACHÃO M., DOMÈNECH R., LOZANO-FRANCISCO M. C., MARTINELL J., MAYORAL E., SANTOS A., VERA-PELÁEZ

Remarks

This species is reported from the Pliocene of southern Tuscany (Brunetti, 2014, Monte Antico, Zanclean, zone MPL3). It was further reported from the Spanish Zanclean of Baix Llobregat (Barcelona, Catalonia), described as the new species *Clavatula acuticostulata* Marquina, 1988. Thick, fusiform shell of medium-large size, spiral ornamentation consists of spiral cords and little threads with different widths; well-defined and spaced axial ribs that occupy the abapical half of the whorl. Slightly sinuous and irregular sutures. Profile of the whorls carinate, sinuous sutural ramp, convex near the adapical suture and strongly concave later on. All the whorls are from semiconvex to almost straight abapically (Marquina, 1988) (Fig. 4. A, D). Description and figures well correspond to *Pleurotoma* (*Drillia*) *torcapeli* Mayer-Eymar, 1891 from the “Astian superieur” of Aramon (Nîmes, southern France) and for this, the name *Crassispira acuticostulata* Marquina, 1988 cannot be used (junior synonym, Brunetti, 2014, p. 67) (Fig. 4. E, H). The characteristics of the teleoconch (e.g., claviform shell, smooth subsutural fold, well evident anal asciola) allow attributing this species to the genus *Crassispira* Swainson, 1840. *Crassispira torcapeli* (Mayer-Eymar, 1891) has a multispiral protoconch (Vera-Peláez & Batlori Aguilà, 1996) a feature not very common for the genus in the Pliocene species of the Mediterranean Basin.

Distribution

Pliocene of Spain and Italy, with chronostratigraphic distribution limited to the Zanclean (Brunetti, 2014; Dominici & Forlì, 2021; Marquina, 1988). Pliocene of France (in Mayer-Eymar, 1891, Zanclean according to Dominici & Forlì, 2021).

Crassispira minor (Foresti, 1897) (Fig. 5 B-F)

Drillia brocchii var. *minor* - Foresti, 1897, p. 238, pl. 9, fig. 13.

Examined material

Two spcms from Vignola (Modena), Pliocene (Piacenzian). (CDB): H 19.9 mm, H 19 mm.

Remarks

Crassispira minor (Foresti, 1897) (Fig. 5. B-F) was first described as *Drillia brocchii* var. *minor*. The original description (see appendix) highlights differences with *Crassispira brocchii* (Bellardi, 1847) (Fig. 5. A, G), such as the smaller dimensions with the same number of whorls, the different shape of the anal fasciola and the aperture. On the basis of our personal data, they have also different chronostratigraphic distribution, the Bellardi's species is exclusive to Zanclean and the Foresti's species is restricted in to the Piacenzian.

Distribution

Pliocene, Piacenzian of Emilia (Italy).

Acknowledgements

We are grateful to Paco Casas, Centro de Interpretación Cabra Jurassica, (Cabra, Cordoba, Spain) and Giano Della Bella, Monterenzio (Bologna, Italy). The authors wish to thank the Editor-in-Chief Paolo G. Albano, Stefano Dominici, Museo di Storia Naturale, University of

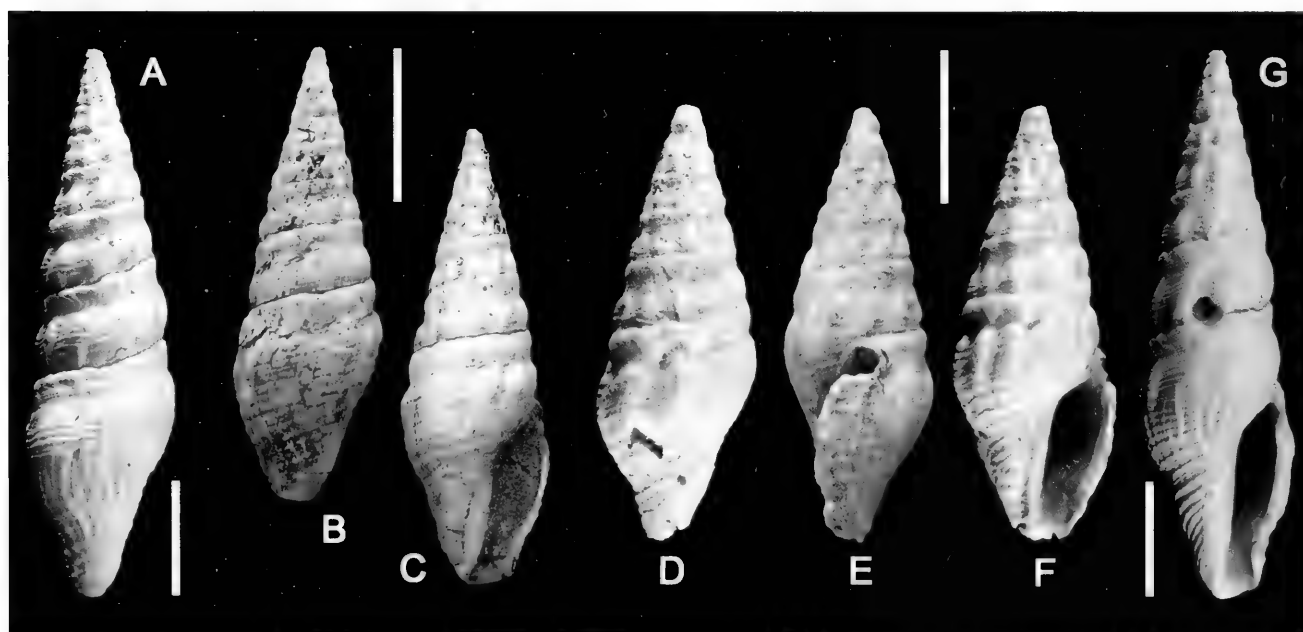


Fig. 5. *Crassispira* spp. B-F. *Crassispira minor* (Foresti, 1897), Vignola (Modena, Italy), Pliocene (Piacenzian); B, C. H 19.9 mm (CDB); D-F. H 19 mm (CDB); A, G. *Crassispira brocchii* (Bellardi, 1847), Rio Rocca (Modena, Italy), Pliocene (Zanclean), H 36 mm (CDB). Scale bar: 5 mm.

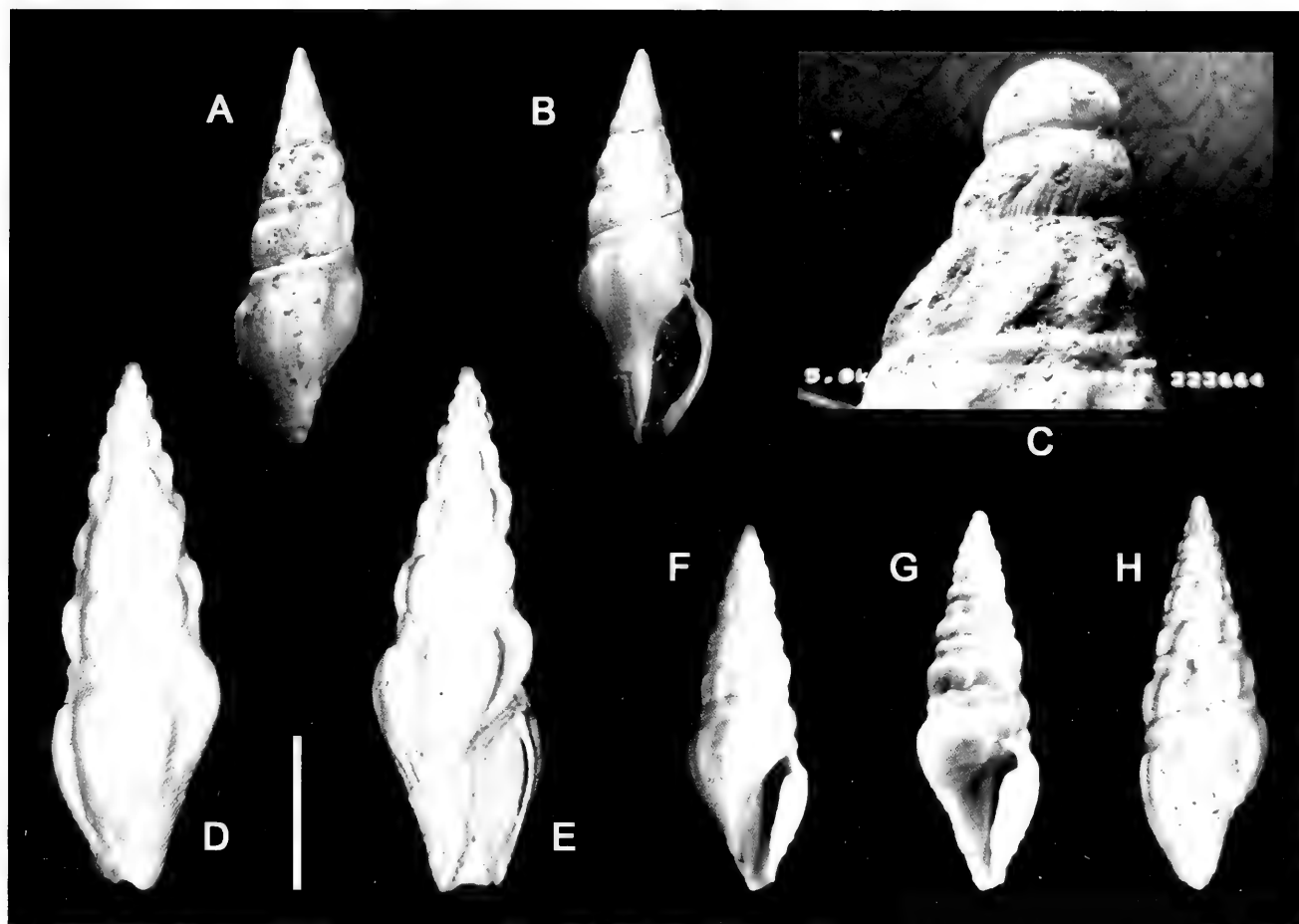


Fig. 3. A-H. *Crassispira* spp.: **A, B.** *Crassispira octoangula* Vera Pelaez, 2002, El Lobillo, Estepona (Spain), Pliocene (Zanclean/Piacenzian), H 13 mm (CMB); **D, E.** *Crassispira pseudosigma* (Brugnone, 1876), Montaione (Firenze, Italy), Pliocene (Piacenzian), H 17.3 mm (CMB); **C, F-H.** *Crassispira calurii* (De Stefani & Pantanelli, 1878), Podere Sant'Ulviere, Colle Val d'Elsa (Siena, Italy), Pliocene (Piacenzian); (**C**) detail of apical whorls after Scarponi & Della Bella (2004, pl. 13, fig. 75). (**F**) H 12 mm (CDB). (**G**) H 12.5 mm (CDB). Corazzano quarry, San Miniato (Pisa, Italy), Pliocene (Piacenzian) (**H**) H 12 mm (CDB). Scale bar: 5 mm.

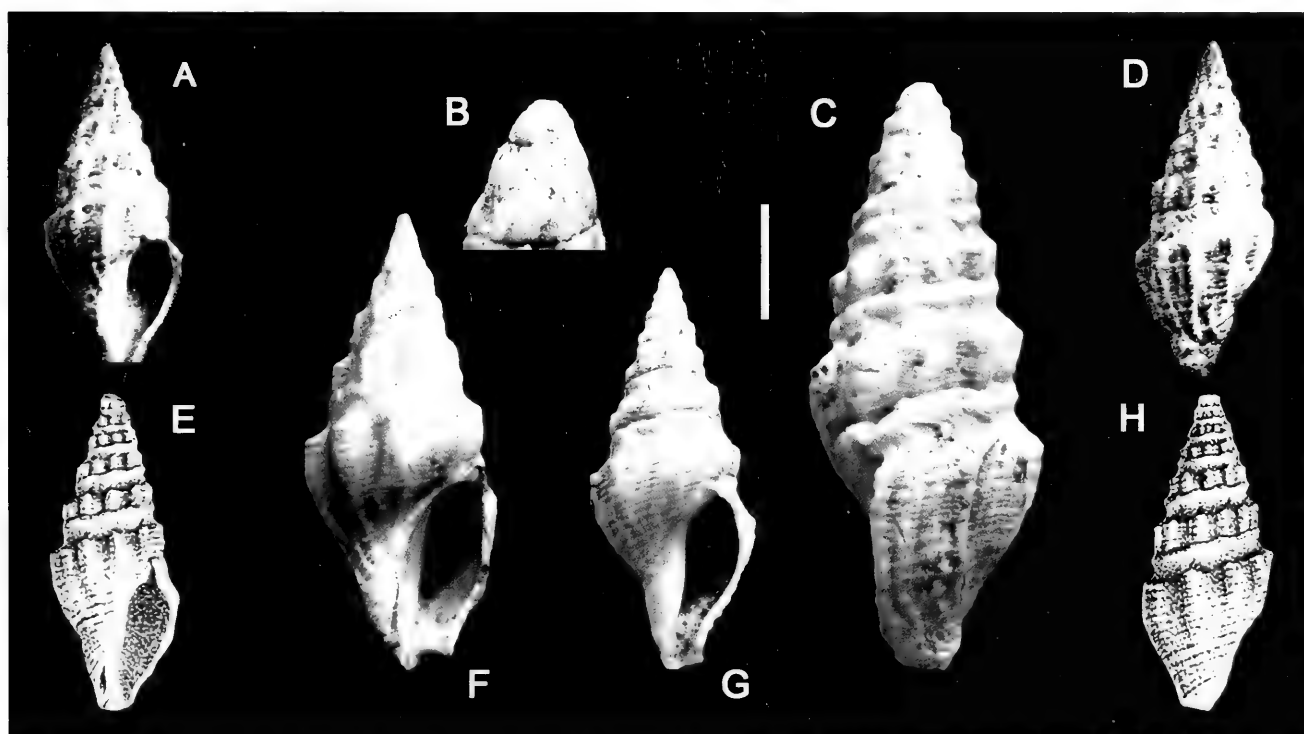


Fig. 4. Original illustrations: **A, D.** *Clavatula acuticostulata* Marquina, 1988, Holotype, Papiol, Baix Llobregat (Barcelona, Spain) Pliocene, H 24.67 mm.; **E, H.** *Pleurotoma (Drillia) torcapeli* Mayer-Eymar, 1891, Aramon, (Nîmes, France) Pliocene, H 28 mm. Both modified, not in scale; **B-F, C, G** *Crassispira torcapeli* (Mayer-Eymar, 1891), Monte Antico (Grosseto, Italy), Pliocene (Zanclean), (**B**) detail of apical whorls, (**F**) H 20 mm (CDB). (**C**) H 27.5 mm (CDB). (**G**) H 17.5 mm (CMB). Scale bar: 5 mm.

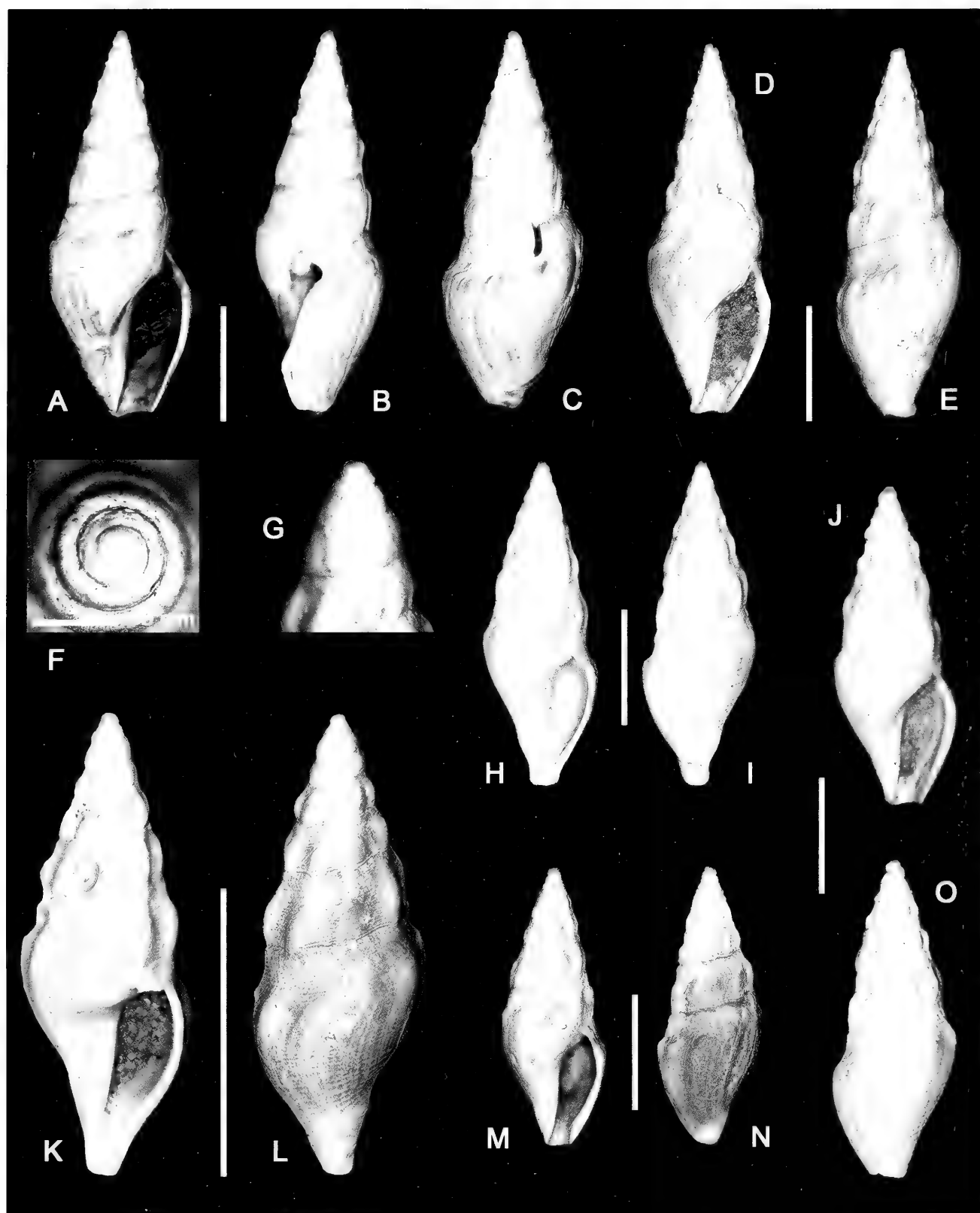


Fig. 2. All the specimens are from Santa Catalina, Lucena del Puerto, Huelva, Guadalquivir Basin (Spain). Pliocene (Zanclean). **A-O** *Crassispira plioibericostricta* n. sp.: **A-C**. Holotype, H 16.8 mm (MSNF, IGF 104840). **D, E**. Paratype 1, H 16.2 mm (MSNF, IGF 104841); **H, I**. Paratype 2, H 14 mm (MSNF, IGF 104842); **J-O**. Paratype 3, H 13.8 mm (MSNF, IGF 104843); **F, G, K, L**. Paratype 4, detail of the protoconch and apical whorls, front and dorsal view, H 8 mm (MSNF, IGF 104844); **M, N**. Paratype 5, H 12.2 mm (CICJ, CJ0734GP). Scale bar: 5 mm.

Crassispira acuticostulata (Marquina, 1988) - Vera-Peláez & Batllori Aguilà, 1996, p. 37, pl. 1, figs 6-7, pl. 2, figs 1-2, pl. 3, fig. 1.

Crassispira torcapeli Mayer-Eymar - Brunetti M., 2014, p. 67, unnumbered fig.

Examined material

Three spcms from Monte Antico (Grosseto, Italy), Pliocene (Zanclean). H 20 mm, H 27.5 mm (CDB); H 17.5 mm (CMB).

covers the whole shell and which makes it appear without spiral sculpture. Among Pliocene species (e.g., Scarponi & Della Bella, 2004), *Crassispira calurii* (De Stefani & Pantanelli, 1878) (Fig. 3. C, F-H), is the one with the greatest affinities. However, this is easily distinguished by the spiral sculpture very evident in the lower part of the last whorl, the less strong axial ribs and more acute outline.

Distribution and habitat

On the basis of the fossil malacofauna present at Podere Sant'Ulivi, rich in *Gibbula* sp., *Bolma* sp., *Cochlis* sp., *Hexaplex* sp., *Cypraea* sp., *Conus* sp., *Chamelea* sp., *Callista* sp. and *Panopea* sp., the species lived at depths corresponding to the infralittoral zone with chronostratigraphic distribution in the lower Piacenzian (Pliocene). Known only from the type locality.

Crassispira plioibericostricta n. sp. (Fig. 2. A-O)

Crassispira calurii (De Stefani & Pantanelli, 1878) - Landau et al., 2011, p. 36, pl. 19, fig. 3.

Type material

Holotype, H 16.8 mm (MSNF, IGF 104840); Paratype 1, H 16.2 mm (MSNF, IGF 104841); Paratype 2, H 14 mm (MSNF, IGF 104842); Paratype 3, H 12.2 mm (CICJ, CJ0734GP); Paratype 4, H 13.8 mm (MSNF, IGF 104843); Paratype 5, H 8 mm (MSNF, IGF 104844).

Additional material

Santa Catalina (Lucena del Puerto, Huelva, Guadalquivir Basin), Spain, Pliocene (Zanclean), 54 spcms. (CMB).

Type locality

Santa Catalina, Lucena del Puerto, Huelva, Guadalquivir Basin, Spain, 37°15'33" N; 06°44'14" W. Pliocene (Zanclean) (Landau et al., 2011).

Origin of the name

From Plio = relative to the Pliocene, iberico = Iberic, relative to Spain, and the latin word *constricta* = narrow, for the narrow shape of the shell.

Description

Small-medium sized shell (maximum H = 19 mm). Protoconch multispiral consisting of 3 whorls without ornamentation. The transition from the protoconch to the teleoconch is marked by the presence of a not very evident orthocline axial rib. Teleoconch narrow, with a spiral angle of about 30 degrees, with an elongated claviform shape, consisting about 6 convex whorls,

their periphery weakly angulate, scarcely shouldered, situated above mid whorl. Whorl profile convex below periphery, concave above, not marked subsutural fold. Shallow undulating suture. Axial ornamentation on the first two whorls consisting of 6-7 slender, not very evident orthocline, slightly nodose ribs, narrower than the interspaces. Ribs more numerous on the others whorls, where they became evident opisthocline, gradually evanescing on the last whorl. Fasciole flattened with spiral ornamentation consisting of numerous spiral striae, visible only at high magnification, crossed with the growth lines. Spiral ornamentation absent on the other surface of the whorl. Last whorl about 1/2 of the total height. Axial ornamentation, on almost the whole whorl, that disappears abapically while a very thin spiral ornamentation crossed with the growth lines becomes evident. Narrow and elongated aperture, thin external lip, wide and shallow anal sinus. Slender columellar callus, wide, short inhalation sinus.

Remarks

Crassispira plioibericostricta n. sp., was previously reported by Landau et al. (2011, plate 19, fig. 3) as *Crassispira calurii* (De Stefani & Pantanelli, 1878) (Fig. 3. C, F-H). *Crassispira calurii* is a different species with paucispiral protoconch, while that of *Crassispira plioibericostricta* n. sp., is multispiral, axial ornamentation with more robust ribs, wider anal fasciola, spiral cords evident in the lower half of the last whorl. In addition, this species differs from other Pliocene species of similar size, in particular from *Crassispira octoangula* Vera Pelaez, 2002 (Fig. 3. A, B) and *Crassispira pseudosigma* (Brugnone, 1876) (Fig. 3. D, E). *Crassispira octoangula*, from the Pliocene of Estepona (Malaga, Spain), has a more angulate spire, more robust axial ribs extended also on the last whorl, anal sinus more closed. *Crassispira pseudosigma*, from the Italian Pliocene, has a paucispiral protoconch, more angulate shell, evident spiral ornamentation, ribs more robust. This taxon is known from the type locality Altavilla Milicia (Palermo), Linari and Treppiè (Barberino Tavarnelle, Firenze), Montaione (Firenze), Ciuciano, San Gimignano (Siena) (Scarponi & Della Bella, 2004), Podere Sant'Ulivi (Colle Val d'Elsa, Siena) and Ficulle (Terni, Umbria) (this paper).

Distribution and habitat

On the basis of the literature (Landau et al, 2011), the species lived at depths corresponding to the circalittoral zone with chronostratigraphic distribution limited to the Zanclean. At present, known only from the type locality.

Crassispira torcapeli (Mayer-Eymar, 1891) (Fig. 4 A-H)

Pleurotoma (*Drillia*) *torcapeli* Mayer-Eymar, 1891, p. 318, pl. 8, fig. 2.

Clavatula acuticostulata Marquina, 1988, p. 1, figs 2-3.

Type Taxon *Crassispira bottae* (Valenciennes in Kiener, 1839) (type by subsequent designation). Mazatlan, Mexico, Present-day.

***Crassispira pseudoglabra* n. sp.**
(Fig. 1. A-H)

Type material

Holotype, H 15.2 mm (MGCC, 25002A); Paratype 1, H 14.5 mm (MSNF, IGF 104839); Paratype 2, H 9 mm (MGCC, 25002B).

Additional material

Podere Sant'Uliviore, Colle Val d'Elsa (Siena), Italy, Pliocene (Piacenzian), 6 spcms. (CMB).

Type locality

Podere Sant'Uliviore, Colle Val d'Elsa (Siena), Italy, 43°26'30,5" N; 11°05'19,8" E.

Origin of the name

For its smooth appearance (from medieval latin *pseudo* = false, *glaber* = hairless) due to a very shallow spiral sculpture, visible with difficulty without the aid of a magnifying glass.

Description

Small-medium sized shell (maximum H = 16 mm). Protoconch paucispiral, papilliform, consisting of 1.5 whorls without ornamentation. The transition from protoconch to teleoconch is marked by a strong axial rib. Teleoconch narrow, with a spiral angle of about 35 degrees, with an elongated claviform shape, consisting of about 7 whorls, weakly angulate at the periphery, with a shallow undulating suture. Evident subsutural fold. Axial ornamentation on the first two-whorls consisting of 6-7 strong, nodose ribs, wider than the interspaces. The number of ribs increases to a maximum of 11-12 on the penultimate whorl. Spiral ornamentation consisting of striae of the same width, about 15 on the penultimate whorl, present also over the fasciole, which is wide and flattened. Last whorl about 3/5 of the total height. Axial ornamentation, on almost the whole whorl, that disappears abapically, where the spiral cords are more evident. Narrow and elongated aperture, thin external lip, strong parietal callus. Shallow, U-shaped anal sinus. Columellar callus strong, wide, short inhalation sinus.

Remarks

Crassispira pseudoglabra n. sp., is easily identifiable by the characteristic very thin spiral sculpture which

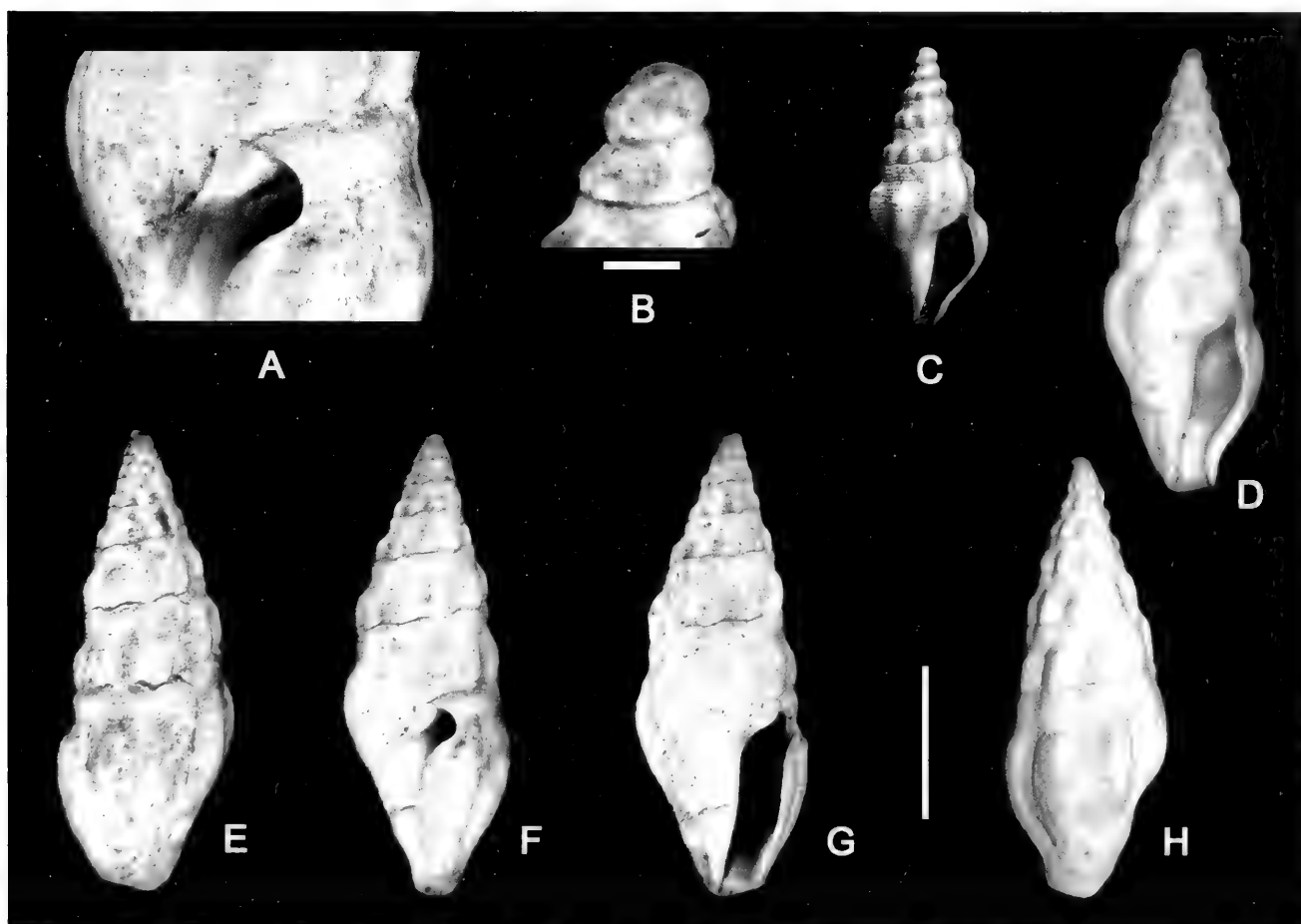


Fig. 1. A-H *Crassispira pseudoglabra* n. sp., Podere Sant'Uliviore, Colle Val d'Elsa (Siena, Italy), Pliocene (Piacenzian); **A, E-G**. Holotype, detail of the anal sinus, dorsal, lateral and front view, H 15.2 mm (MGCC, 25002A); **B, C**. Paratype 1, detail of apical whorls, front view, H 9 mm (MGCC, 25002B); **D, H**. Paratype 2, H 14.5 mm (MSNF, IGF 104839). Scale bars: 1 mm, 5 mm.

ca tarbelliana (Grateloup, 1840), *Euthriofusus* sp., *Amalda glandiformis* (Brocchi, 1814) morfo *elongata* (Deshayes, 1830), *Trigonostoma imbricatum* (Hörnes, 1856), *Clavatula* aff. *evae* (Hoernes & Auinger, 1882), *Perrona jouanneti* (Desmoulins, 1842). In the Guadalquivir Basin (Huelva Formation), there are also numerous endemic fossil molluscs absent in the Pliocene of the Mediterranean Basin, including *Crepidula lucenica* Landau, 1984, *Purpurellus helenae* Landau, 1984, *Aplous pseudoassimilis* Brunetti & Della Bella 2016, *Nassarius patnuttalli* Landau, da Silva & Gilli, 2009, *Cymbium ibericum* Landau & Marquet, 2000, *Akardita iberica* La Perna, Brunetti & Della Bella, 2018, *Donax garciai* Lozano-Francisco & Landau, 1999, *Donax triangula* Lozano-Francisco & Landau, 1999, *Callista vera* Lozano-Francisco & Landau, 1999.

Here, we further expand the comparison by discussing the taxonomic position of some species included in the genus *Crassispira* Swainson, 1840. The genus is known from the Eocene (Pacaud & Le Renard, 1995) and had a subsequent increase in the number of species starting from the Oligocene (Lozouet, 2017), up to more than 150 living species (Powell, 1966). These are predatory animals whose radula is characterized by a robust membrane on which two to four rows of teeth are set. All species are currently widespread in the tropical and subtropical waters of the globe, possessing a marked warm water affinity character.

The shells have a claviform or fusiform profile with dimensions ranging from 10 mm to a maximum of 70 mm in height. The protoconch, usually paucispiral, is smooth. On the last whorl there may be a tenuous axial, or more rarely, spiral sculpture. Teleoconch with siphonal canal generally short, anal sinus, located on the sutural ramp, with a well-developed callus (Della Bella & Scarponi, 2004). The number of species of *Crassispira* decreased in the Mediterranean Basin starting from the cooling that occurred during the Piacenzian, until their definitive disappearance during the lower Pleistocene (Dominici et al., 2020).

Geological setting

The localities of provenance of the type material are Podere Sant'Ulivi, in Tuscany, Italy, and Santa Catalina, Huelva province, Guadalquivir Basin, Spain. These are located in two different tectonic and paleogeographic settings which will be briefly reviewed here, together with the local stratigraphy.

The succession cropping out at Podere Sant'Ulivi (43°26'30,5" N, 11°05'19,8" E), between San Gimignano and Colle Val d'Elsa, is characterized in the basal part by clays and silty clays, with a few meters of fossiliferous sands and, in the upper part, by clays gradually replaced by clayey sands, followed by medium to fine-grained sands intercalated with beds of calcarenite. The succession is part of the Pliocene Valdelsa Basin and the locality is reported in a general review on the taxonomic diversity and stratigraphic distribution of Mediterranean Pliocene fauna (Monegatti & Raffi, 2001). Recent

chronostratigraphic studies of the Valdelsa Basin attribute this richly fossiliferous succession to the lower-mid Piacenzian. This regional pattern is possibly coincident with the 3.5-2.8 Ma interval when a warm climate and sea level highstand are globally recorded (Benvenuti et al., 2014; Dominici et al., 2018; see also Capezzuoli et al., 2005; Nalin et al., 2016). The sediments of Podere Sant'Ulivi, like others of nearby outcrops (e.g., Le Piaggiole, Poggibonsi), are referred to planktonic foraminifera biozones MPL4b and MPL5a (lower part, references in Benvenuti et al., 2014) and to MPMU1 of Mediterranean Pliocene Molluscan Units (Monegatti & Raffi, 2001).

The second type locality Santa Catalina (37°15'33" N, 06°44'14" W), near Lucena del Puerto, Huelva, Guadalquivir Basin, Spain, is included among those mentioned in a general review of the local gastropod fauna (Landau et al., 2011, Text fig. 2, site 4). The specimens were collected in the grey sands of the lower part of the Huelva Sands Formation, locally overlain by yellow sands with a different malacofaunal assemblages (Landau et al., 2011). Many of the taxa previously collected in grey sands are interpreted as endemic to the Lucena region (Landau, 1984; Landau et al., 2011). This sedimentary unit represents shallow, offshore deposition in a fine sandy bottom (Landau & Marquet, 2000). This is referred to the lower Pliocene (Zanclean) and included in faunistic unit MPMU1 (Landau et al., 2011: 49-52).

Material and methods

The study is based on eighty specimens collected from the above outcrops and on comparisons with public collections hosted at museums of the universities of Bologna and Florence, Italy, and at the Centro de Interpretación Cabra Jurassica in Cabra, Spain, and with some private collections. Suprageneric systematics follows Bouchet et al. (2011) and the World Register of Marine Species (WoRMS, 2021). Some of the material used for comparison is described in the appendix. Abbreviations and acronyms: H: maximum height of the shell, measured from the apex to the anterior end of the siphon canal; spcms: specimens. For public collections: MGGC = Della Bella Collection, housed in the Museo di Geologia e Paleontologia "Giovanni Capellini", University of Bologna (Italy); MSNF = Museo di Storia Naturale di Firenze (Italy); IGF = Catalogue entry in MSNF; CICJ = Centro de Interpretación Cabra Jurassica, Cabra, (Spain). For private collections: CMB = Brunetti collection; CDB = Della Bella Collection.

Systematics

Class Gastropoda Cuvier, 1795

Subclass Caenogastropoda Cox, 1960

Superfamily Conoidea J. Fleming, 1822

Family Pseudomelatomidae J. P. E. Morrison, 1966

Genus *Crassispira* Swainson, 1840

Some notes on the Genus *Crassispira* Swainson, 1840 (Gastropoda: Pseudomelatomidae) with the description of two new species from the Italian and Spanish Pliocene

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Abstract

Two new Pliocene species belonging to the genus *Crassispira* Swainson, 1840 (Gastropoda: Pseudomelatomidae) are described: *Crassispira pseudoglabra* n. sp., from sediments attributed to the Piacenzian from Podere Sant'Ulivi, Colle Val d'Elsa (Siena), central Tuscany (Italy), and *Crassispira plioibericostricta* n. sp., from Santa Catalina, Lucena del Puerto, Huelva, from the Spanish Atlantic Pliocene (Zanclean). Two other species of the same genus, rarely mentioned in the literature after the original description, are also illustrated and discussed: *Crassispira minor* (Foresti, 1897), from the Piacenzian of Emilia (northern Apennines, Italy), and *Crassispira torcapeli* (Mayer-Eymar, 1891), present both in the Zanclean of Spain (Baix Llobregat, Barcelona, Catalonia) and in southern Tuscany (Monte Antico, Civitella Paganico, Grosseto, Italy). *Crassispira pseudoglabra* n. sp., is currently known only from the Piacenzian of the type locality in Tuscany; *Crassispira minor* (Foresti, 1897), is known only for the Piacenzian of Emilia; *Crassispira pseudosigma* (Brugnone, 1876), originally described for the Piacenzian of Altavilla Milicia (Sicily) is known for some localities in Tuscany (Scarponi & Della Bella, 2004); *Crassispira plioibericostricta* n. sp., is currently exclusive to the Zanclean of Santa Catalina, Huelva, Spain (type locality); *Crassispira octoangula* Vera Peláez, 2002, is reported only in the Pliocene of Estepona (Spain); finally *Crassispira brocchii* (Bellardi, 1847), *Crassispira calurii* (De Stefani & Pantanelli, 1878) and *Crassispira torcapeli* (Mayer-Eymar, 1891), are present in both Spanish and Italian Pliocene sediments.

Key words

Pseudomelatomidae, Pliocene, Italy, Spain, taxonomy.

Riassunto

Sono descritte due nuove specie plioceniche appartenenti al genere *Crassispira* Swainson, 1840 (Gastropoda: Pseudomelatomidae), *Crassispira pseudoglabra* n. sp., da sedimenti attribuiti al Piacenziano di Podere Sant'Ulivi, Colle Val d'Elsa (Siena), Toscana centrale, e *Crassispira plioibericostricta* n. sp., da Santa Catalina, Lucena del Puerto, Huelva, del Pliocene atlantico spagnolo (Zancleano). Sono inoltre figurate e discusse altre due specie poco citate in letteratura: *Crassispira minor* (Foresti, 1897), del Piacenziano dell'Emilia (Appennino settentrionale) e *Crassispira torcapeli* (Mayer-Eymar, 1891), presente sia nello Zancleano della Spagna (Baix Llobregat, Barcellona, Catalogna), sia in quello della Toscana meridionale (Monte Antico, Civitella Paganico, Grosseto). Si confrontano quindi le specie trattate annotando la loro presenza o assenza nelle contemporanee malacofaune spagnole o italiane: *Crassispira pseudoglabra* n. sp., è al momento nota solo dal Piacenziano della località tipo, così come *Crassispira minor* (Foresti, 1897), lo è dal Piacenziano dell'Emilia. *Crassispira pseudosigma* (Brugnone, 1876), originariamente descritta dal Piacenziano di Altavilla è segnalata da alcune località della Toscana (Scarponi & Della Bella, 2004); *Crassispira plioibericostricta* n. sp., è al momento esclusiva dello Zancleano di Santa Catalina, Huelva, Spagna (località tipo), *Crassispira octoangula* Vera Peláez, 2002, è segnalata solo per il Pliocene di Estepona (Spagna), mentre *Crassispira brocchii* (Bellardi, 1847), *Crassispira calurii* (De Stefani & Pantanelli, 1878) e *Crassispira torcapeli* (Mayer-Eymar, 1891), sono presenze in comune nei sedimenti pliocenici spagnoli e italiani.

Parole chiave

Pseudomelatomidae, Pliocene, Italia, Spagna, tassonomia.

Introduction

A large number of recent taxonomic studies on the malacofauna of the Spanish Pliocene has greatly contributed to our knowledge of the Mediterranean and Atlantic fauna (e.g., Landau, 1984; Landau & Marquet, 2000; Landau & Feshe, 2004a; Landau et al., 2003, 2004, 2004b, 2006, 2006a, 2006b, 2006c, 2007, 2009, 2011, 2015; Vera-Peláez, 2002; Vera-Peláez & Batlori Aguilà, 1996; Vera-Peláez & Lozano-Francisco, 2004; Vera Peláez et al., 1995, 1995a, 1995b, 2004). This literature, coupled with a

better chronostratigraphic constrain of the fossil record (Aguirre et al., 2006), has allowed a more direct comparison with the Italian Pliocene malacofauna, expanding previous knowledge (e.g., Brunetti, 2016, 2020, 2020a; Brunetti & Della Bella, 2014, 2016; Brunetti et al., 2006, 2008, 2009, 2014). The comparison between the assemblages of fossil molluscs from the Pliocene of central Italy and those from the Atlantic Pliocene of the Guadalquivir Basin has ascertained the absence of Miocene relics in the former and their presence in the latter, including *Ficus* cfr. *conditus* (Brogniart, 1823), *Pleuroplo-*

conch, it is impossible to reach conclusions regarding the status of the relationship between these two taxa.

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References

ALTIMIRA C., 1978. Moluscos marinos de las costas del NW de África (Expedición "Atlor VII"). *Resultados Expediciones Científicas del Buque Oceanográfico 'Cornide de Saavedra'*, 7: 173–193.

ARDOVINI R. & COSSIGNANI T., 2004. *West African Seashell*. Museo Malacologico Piceno, Cupra Marittima, L'Informatore Piceno, Ancona, 317 pp.

CLENCH, W.J. & TURNER R.D., 1950. The genera *Sthenorytis*, *Cirsotrema*, *Acirsa*, *Opalia* and *Amaea* in the Western Atlantic. *Johnsonia*, 2 (29): 221–246.

COSSIGNANI T. & ARDOVINI R., 2011. *Malacologia Mediterranea, Atlante delle conchiglie del Mediterraneo*. L'Informatore Piceno, Ancona, 536 pp.

GARCÍA, E.F. & LEE H.G., 2002. Report on molluscan species found in the offshore waters of Louisiana, including many extensions of known range and unnamed species. *American Conchologist*, 30 (4): 10–13.

RIOS E. DE C., 2009. *Compendium of Brazilian Sea Shells*. Editora Evangraf, Rio Grande, 668 pp.

ROLÁN E., 2005. *Malacological Fauna From The Cape Verde Archipelago. Part 1, Polyplacophora and Gastropoda*. Conchbooks, 455 pp.

SEGBERS, W., SWINNEN, F. & DE PRINS, R., 2009. *Marine Molluscs of Madeira: The living marine molluscs of the province of Madeira (Madeira and Selvagens Archipelago)*. 1st Edition. Snoeck Publishers. 612 pp; pls 1–90.

SOCIETÀ ITALIANA DI MALACOLOGIA, 2021. *Sistematica Mediterranea*. Accessed through: https://www.societaitalianadimalacologia.it/index.php?option=com_content&view=article&id=816:pyramidellidae&catid=108:mediterranea&Itemid=191, on 10/08/2021

SMRIGLIO C. & MARIOTTINI P., 1999. Molluschi del mar Tirreno centrale. Contributo XII. Segnalazione di due rari Epitonidiidae batiali per le coste lazionali (Gastropoda, Ptenoglossa). *Bollettino Malacologico*, Roma, 34 (9-12): 137–140, [1998] 1999.

WATSON, R.B., 1897. On the marine mollusca of Madeira; with descriptions of thirty-five new species, and an index-list of all the known sea-dwelling species of that island. *Journal of the Linnean Society of London. Zoology*. 26: 233–329; pls 19-20.

WEIL A., BROWN L. & NEVILLE B., 1999. *The Wenteltrap book. Guide to the Recent Epitonidae of the world*. Evolver s.r.l. Roma, 245 pp.

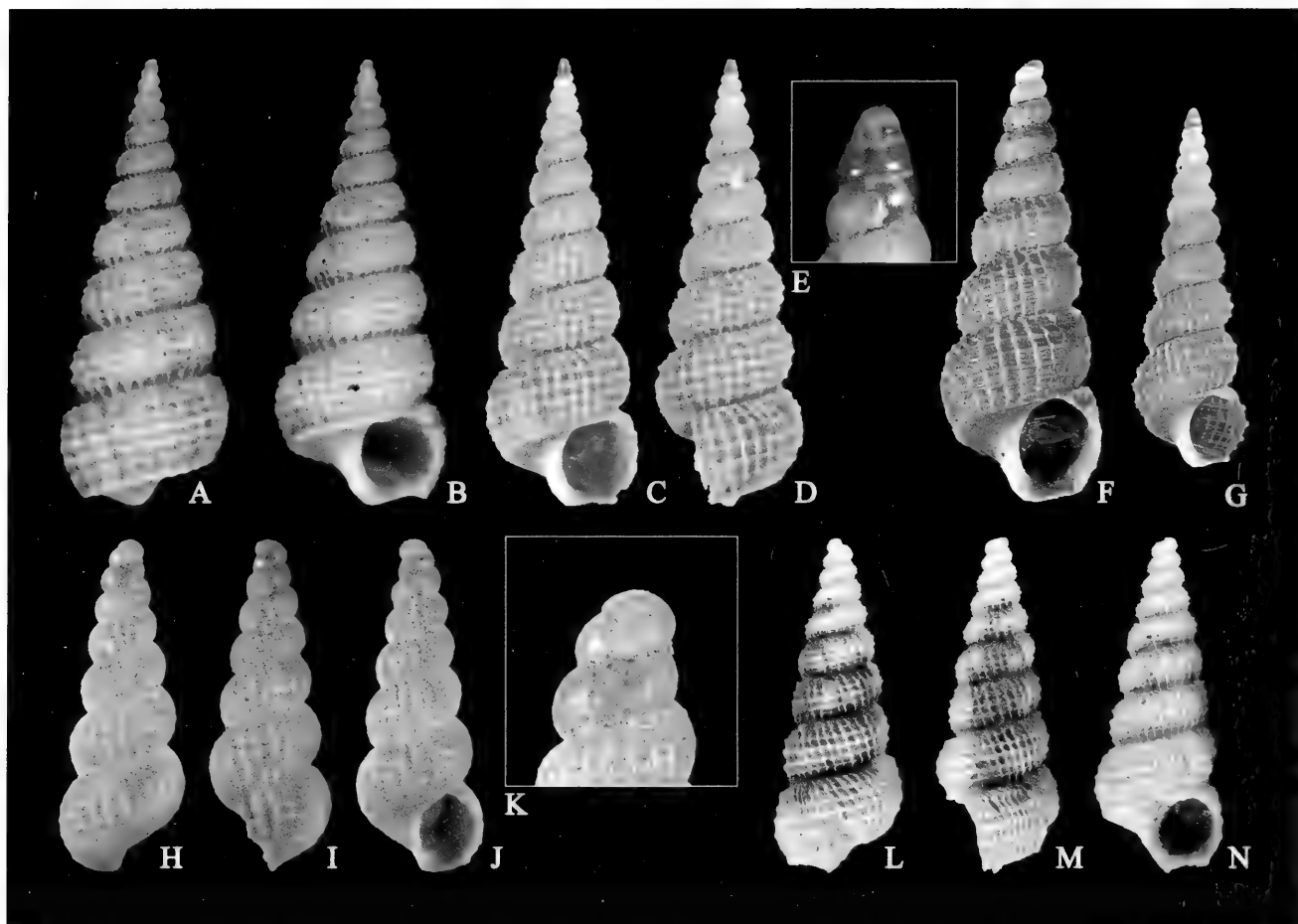


Fig. 1. **A-G** *Amaea retifera* (Dall, 1889). **A, B.** Lectotype North Carolina (US), Cape Hatteras, 90 m, 12.1 x 4.6 mm (USNM 83733); **C-E.** Alboran Sea, 200 m, 2015, 10.5 x 3.6 mm (AP); **F.** Capo Corso, Corse, France, 700 m, 7.5 x 2.7 mm (CS). **G.** Alboran Sea, 200 m, 2015, 6.1 x 3.6 mm (FG); **H-K.** *Papuliscala cerithielloides* Bouchet & Warén, Alboran Sea, 500 m, 3.5 x 1.4 mm (AP); **L-N.** *Amaea bronni* (Seguenza, 1876). Guidonia, Latium, Italy. Pliocene, 18.1 x 6.9 mm (AN).

Scaloria rhips Watson, 1897: 250-251; pl. 19, fig. 17

Examined Material

One shell, Alboran Sea, 200 m. 2015. (AP); one shell, Alboran Sea, 200 m. 2015. (FG); 30 shells, Alboran Sea, 120 m. (CS); 9 shells, Alboran Sea, 120 m. (AN); one shell, Cap Corse, Corse, France, 700 m (CS); one specimen off Ġnejna Bay, outer reef, in sand and weed fragments, 160 m, 05/08/2017. (CM).

Discussion

In this paper, *A. retifera* is officially reported from Corse, France, at depth of 700 m on the basis of a well-preserved single shell (Fig. 1. F); in the Alboran Sea at depths between 120 and 200 m on the basis of 7 well-preserved adult shells and 34 juvenile ones in various degrees of preservation (Fig. 1. C-E, G). A single living specimen was dredged off Ġnejna Bay, Malta, at depth of 160 m.

Cossignani & Ardevini (2011) showed a specimen from the Sicily Channel identified as *Papuliscala* cfr. *cerithielloides* which is indeed a damaged specimen of *A. retifera*. This is the first unofficial published record regarding this species in Mediterranean Sea.

Papuliscala cerithielloides Bouchet & Warén, 1986 (Fig. 1. H-K) show a similar cancellate sculpture of the teleoconch, but both axial and spiral sculpture are smoother. The main differences between the two species are the protoconch and the shell size. *P. cerithielloides* has a white paucispiral protoconch of around 1.5 whorls, typical of recent species of the genus *Papuliscala*, while *A. retifera* has a brown multispiral protoconch of around 3.5 - 4 whorls. The maximum size known for *P. cerithielloides* is 5 mm (Smriglio & Mariottini, 1999) while the one of *A. retifera* is 30 mm (Clench and Turner, 1950).

A. retifera from the Western Atlantic possesses a bigger and wider shell compared to the Eastern Atlantic specimens, and this is evident from the lectotype (Fig. 1. A, B). *Scaloria rhips* Watson, 1897, a synonym of *A. retifera*, possesses the shell features of Eastern Atlantic specimens, since the type comes from the Madeira Archipelago (NMW.1955.158.24372). The conchological differences between these two populations could be explained by infraspecific variability, that produced this unique feature due to the geographical distance. *Amaea bronni* (Seguenza, 1876) (Fig. 1. L-N) from the Italian Pliocene is morphologically very similar to Western Atlantic specimens of *A. retifera*, having both a considerable variability of axial and spiral sculpture; however, without having specimens of *A. bronni* with intact proto-

On the presence of *Amaea retifera* (Gastropoda: Epitoniidae) in the Mediterranean Sea

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Abstract

In this work, the presence of *Amaea retifera* (Dall, 1889) in the Mediterranean Sea is reported for the first time. These records widen the known distribution of this amphiatlantic species, found on the Western and Eastern sides of the Atlantic Ocean, at depths between 24 to 690 m.

Key words

Amaea retifera, Epitoniidae, Mollusca, Mediterranean Sea.

Riassunto

In questo lavoro, viene segnalata per la prima volta la presenza di *Amaea retifera* (Dall, 1889) nel Mar Mediterraneo. Queste segnalazioni allargano la distribuzione conosciuta di questa specie amfiatlantica, rinvenuta sulle coste Occidentali e Orientali dell'Oceano Atlantico, a profondità comprese tra 24 e 690 m.

Parole chiave

Amaea retifera, Epitoniidae, Mollusca, Mare Mediterraneo.

Introduction

According to WoRMS (accessed on 15/11/2020), 795 recent species are currently placed in the family Epitoniidae Berry, 1910 (1812), with a worldwide distribution. The genus *Amaea* H. Adams & A. Adams, 1853 consists of 48 species mostly distributed worldwide. This genus is characterized by thin and very sculptured shells. *Amaea retifera* (Dall, 1889) is an amphiatlantic species originally described for North Carolina, United States (Watson R.B., 1897) at a depth of about 90 m (USNM 83733) and so later reported in Florida, Gulf of Mexico, Barbados (Clench and Turner, 1950), Brazil (Rios, 2009) and Louisiana (García & Lee, 2002). In the Eastern Atlantic Ocean, the species is reported in Cape Verde (Rolán, 2005), Mauritania (Ardovini 2004), Western Sahara (Altimira, 1978) and Madeira Archipelago (Segers, Swinnen & de Prins, 2009). Cossignani & Ardovini, 2011 showed a specimen from the Sicily Channel identified as *Papuliscala* cfr. *cerithielloides* which is indeed a damaged specimen of *A. retifera*. This is the first unofficial published record regarding this species in Mediterranean Sea. Thee present work is the first officially reports this species in the Mediterranean Sea, and is consequently the first report of the genus *Amaea* H. Adams & A. Adams, 1853 in the recent Mediterranean malacofauna. The genus is reported in the Italian Pliocene malacofauna with 7 species.

Material and methods

The studied material was picked up from bottom sam-

ples collected by local fishermen. The WoRMS database and the systematic list of the Italian Malacological Society (Società Italiana di Malacologia, 2021) are used for nomenclature. Reported sizes are in millimeters and given as shell height × shell width. Photos were obtained with a Nikon D90 and processed with Adobe Photoshop CC®.

Abbreviations and acronyms

AN: Andrea Nappo collection (Quartu Sant'Elena, Italy); **AP:** Attilio Pagli collection (Empoli, Italy); **CS:** Carlo Sbrana collection (Leghorn, Italy); **CM:** Constantine Mifsud collection (Rabat, Malta); **FG:** Francesco Giusti collection (Leghorn, Italy); **MNHN:** Muséum National d'Histoire Naturelle (Paris, France); **NMW:** National Museum Wales (Cardiff, United Kingdom); **SIM:** Società Italiana di Malacologia (Italian Malacological Society); **WoRMS:** World Register of Marine Species.

Results and discussion

Taxonomy

Phylum Mollusca Cuvier, 1797
Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Family Epitoniidae Berry, 1910 (1812)
Genus *Amaea* H. Adams & A. Adams, 1853
Amaea retifera (Dall, 1889) [Scalaria]
(Fig. 1. A-G)

Scala retifera Dall, 1889: 312

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- (3): 231–236.
- <https://doi.org/10.1007/s13127-011-0048-0>
- HOLMER M., DUARTE C.M. & MARBÁ N., 2003. Sulfur cycling and seagrass (*Posidonia oceanica*) status in carbonate sediments. *Biogeochemistry*, **66**: 223–239.
- LASERON C.F., 1954. Revision of the Liotiidae of New South Wales. *The Australian Zoologist*, **12** (1): 1–25.
- MARSHALL B.A., 1988. Skeneidae, Vitrinellidae and Orbitestellidae (Mollusca: Gastropoda) associated with biogenic substrata from bathyal depths off New Zealand and New South Wales. *Journal of Natural History*, **22** (4): 949–1004. <https://doi.org/10.1080/00222938800770631>
- MANOUSIS T., ZAMINOS G., SAMARA E., MBAZIOS G. & GALINOU-MITSOU DI S., 2021. *Rissoella angeli* n. sp. (Gastropoda: Heterobranchia: Rissoellidae) and additional new records of molluscs for E. Mediterranean and the Hellenic Seas. *Xenophora Taxonomy*, **31**: 51–70.
- BAZIOS G., KONTADAKIS C., GALINOU-MITSOU DI S. & MANOUSIS T., 2020. New gastropod records for the Mediterranean and the Hellenic seas. *Xenophora taxonomy*, **27**: 34–58.
- MIDDELFART P.U., KIRKENDALE L.A. & WILSON N.G., 2016. Australian tropical marine micromolluscs: an overwhelming bias. *Diversity*, **8** (3): 17. <https://doi.org/10.3390/d8030017>
- MOLLUSCABASE EDS., 2021. MolluscaBase. Accessed at <http://www.molluscabase.org> on 2021-01-30
- MOLLUSCABASE EDS., 2021a. MolluscaBase. Cornirostridae Ponder, 1990. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=23011> on 2021-01-30
- MOLLUSCABASE EDS., 2021b. MolluscaBase. *Tomura* Pilsbry & McGinty, 1946. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=137844> on 2021-01-30
- MOLLUSCABASE EDS., 2021c. MolluscaBase. Hyalogyrinidae Warén & Bouchet, 1993. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=23058> on 2021-01-30
- OLIVER J.D., TEMPLADO J. & KERSTING D., 2012. Gasterópodos marinos de las islas Columbretes (Mediterráneo occidental). *Iberus*, **30** (2): 49–87. <http://doi.org/10.5281/zenodo.4558169>
- OLIVERIO M., 1983. Il genere *Tharsiella* in Mediterraneo (Archaeogastropoda: Skeneidae). *Notiziario CISMA*, **4** (1-2): 1–10.
- OLIVERIO M., 1985. Ancora su *Tharsiella depressa* (Granata, 1877). *Notiziario CISMA*, **5** (1-2): 6–8.
- OLIVERIO M., 1988. Distribuzione geografica di (?)*Tharsiella depressa* (Granata, 1877) (Archaeogastropoda: Skeneidae). *Notiziario CISMA*, **11**: 27–29.
- OLIVERIO M., 2003. The Mediterranean molluscs: the best known malacofauna of the world ... so far. *Biogeographia*, **24**: 195–208. <https://doi.org/10.21426/B6110145>
- OUNIFI BEN AMOR K., RIFI M., GHANEM R., DRAEIF I., ZAOUALI J. & BEN SOUSSI J., 2016. Update of alien fauna and new records from Tunisian marine waters. *Mediterranean Marine Science*, **17**: 124–143. <https://doi.org/10.12681/mms.1371>
- PEÑAS A., ROLÁN E., LUQUE A.A., TEMPLADO J., MORENO D., RUBIO F., SALAS C., SIERRA A. & GOFAS S., 2006. Moluscos marinos de la isla de Alborán. *Iberus*, **24** (1): 23–151. <http://doi.org/10.5281/zenodo.4527554>
- PILSBRY H.A. & MCGINTY T.L., 1945. Cyclostrematidae and Vitrinellidae of Florida. I. *The Nautilus*, **59** (1): 1–13, pl. 1–2.
- PILSBRY H.A. & MCGINTY T.L., 1946. Vitrinellidae of Florida, Part 4. *The Nautilus*, **60** (1): 12–18, pl. 2.
- PONDER W.F., 1990. The anatomy and relationships of a marine valvatoidean (Gastropoda: Heterobranchia). *Journal of Molluscan Studies*, **56** (4): 533–555. <https://doi.org/10.1093/mollus/56.4.533>
- PONDER W.F., 1998. Superorder Heterobranchia, in Beesley P.L., Ross G.J.B. & Wells A. (eds.), *Mollusca: the southern synthesis. Fauna of Australia*. Vol. 5B, CSIRO Publishing, Melbourne: 854–869.
- ROMANI L. & SBRANA C., 2016. A new Mediterranean species of the Cornirostridae (Gastropoda, Heterobranchia), with notes on the genus *Tomura*. *Iberus*, **34** (1): 55–61. <http://doi.org/10.5281/zenodo.4603235>
- RUBIO F., ROLÁN E. & FERNANDES F., 1993. *Hyalogyra necrophaga* n. sp. primera especie del género para el Océano Atlántico. *Bollettino Malacologico*, **28** (5-12): 145–148.
- RUBIO F., ROLÁN E. & FERNÁNDEZ-GARCÉS R., 2013. Heterobranch Gastropods from Cuba: the family Cornirostridae (Heterobranchia, Valvatoidea). *Iberus*, **31** (1): 75–85. <http://doi.org/10.5281/zenodo.4579621>
- SABELLI B. & TAVIANI M., 2014. The making of the Mediterranean molluscan biodiversity, in Goredó, S., Dubinsky, Z. (eds.), *The Mediterranean Sea: Its History and Present Challenges*. Springer, Dordrecht: 285–396. https://doi.org/10.1007/978-94-007-6704-1_16
- SCAPERROTTA M., BARTOLINI S. & BOGI C., 2018. *Accrescimenti: stadi di accrescimento dei molluschi marini del Mediterraneo*. L'Informatore Piceno, Ancona. Vol. IX. 192 pp.
- TRINGALI L.P., 2001. Marine malacological records (Gastropoda, Prosobranchia, Heterobranchia, Opisthobranchia and Pulmonata) from Torres de Alcalá, Mediterranean Morocco, with the description of a new philinid species. *Bollettino Malacologico*, **37** (9-12): 207–222.
- VAFIADIS P., 2016. A Victorian record and range extension of the extraordinary microsnail *Cornirostra pellucida* (Laseron, 1954) (Heterobranchia: Cornirostridae). *Newsletter of the Malacological Society of Australasia*, **157**: 3–4.
- VERDUIN A., 1977. On a remarkable dimorphism of the apices in many groups of sympatric, closely related marine gastropod species. *Basteria*, **41**: 91–95.
- WARÉN A., 1991. New and little known Mollusca from Iceland and Scandinavia. *Sarsia*, **76** (1-2): 53–124. <https://doi.org/10.1080/00364827.1991.10413466>
- WARÉN A., 1992. New and little known “Skeneimorph” Gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean. *Bollettino Malacologico*, **27** (10-12): 149–248.
- WARÉN A. & BOUCHET P., 1993. New records, species, genera, and a new family of gastropods from hydrothermal vents and hydrocarbon seeps. *Zoologica Scripta*, **22** (1): 1–90. <https://doi.org/10.1111/j.1463-6409.1993.tb00342.x>
- WARÉN A., GOFAS S. & SCHANDER G., 1993. Systematic position of three European heterobranch gastropods. *The Veliger*, **36** (1): 1–15.
- WARÉN A., CARROZZA F. & ROCCHINI R., 1997. Description of two new species of Hyalogyrinidae (Gastropoda, Heterobranchia) from the Mediterranean. *Bollettino Malacologico*, **32** (1-4): 57–66.
- WARÉN A. & BOUCHET P., 2001. Gastropoda and Monoplacophora from hydrothermal vents and seeps new taxa and records. *The Veliger*, **44** (2): 116–231.
- WARÉN A. & BOUCHET P., 2009. New gastropods from deep-sea hydrocarbon seeps off West Africa. *Deep Sea Research Part II: Topical Studies in Oceanography*, **56** (23): 2326–2349. <https://doi.org/10.1016/j.dsr2.2009.04.013>

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References

- ALBANO P.G., SABELLI B. & BOUCHET P., 2011. The challenge of small and rare species in marine biodiversity surveys: Microgastropod diversity in a complex tropical coastal environment. *Biodiversity and Conservation*, **20**: 3223–3237. <https://doi.org/10.1007/s10531-011-0117-x>
- AISSAOUI C., GALINDO L.A., PUILLANDRE N. & BOUCHET P., 2017. The nassariids from the Gulf of Gabès revisited (Neogastropoda, Nassariidae). *Marine Biology Research*, **13**: 370–389. <https://doi.org/10.1080/17451000.2016.1273528>
- AISSAOUI C., PUILLANDRE N., BOUCHET P., FASSIO G., MODICA M.V. & OLIVERIO M., 2016. Cryptic diversity in Mediterranean gastropods of the genus *Aplus* (Neogastropoda: Buccinidae). *Scientia Marina*, **80**: 521–533. <https://doi.org/10.3989/scimar.04422.12A>
- AMATI B. & SMRIGLIO C., 2016. Taxonomic notes on the *Alvania dictyophora*-complex with the description of *Alvania desabatae* spec. nov. (Gastropoda, Rissoidae) from the Mediterranean Sea. *Iberus*, **34** (2): 163–180. <http://doi.org/10.5281/zenodo.4603981>
- AMATI B., APPOLLONI M., QUAGGIOTTO E., SMRIGLIO C. & OLIVERIO M., 2019. Notes on some taxa of the *Alvania lineata*-complex with the descriptions of three new species from the Mediterranean Sea (Gastropoda: Rissoidae). *Iberus*, **37** (1): 81–112. <http://doi.org/10.5281/zenodo.4774269>
- AMATI B., APPOLLONI M., GIULIO A., SCUDERI D., SMRIGLIO C. & OLIVERIO M., 2020. Revision of the Recent *Alvania scabra* (Philippi, 1844) complex (Mollusca, Gastropoda, Rissoidae) from the Mediterranean Sea with the description of a new species. *Zootaxa*, **4767** (3): 415–458. <http://dx.doi.org/10.11646/zootaxa.4767.3.3>
- APPOLLONI M., SMRIGLIO C., AMATI B., LUGLIÈ L., NOFRONI I., TRINGALI L.P., MARIOTTINI P. & OLIVERIO M., 2018. Catalogue of the primary types of marine molluscan taxa described by Tommaso Allery Di Maria, Marquis of Monterosato, deposited in the Museo Civico di Zoologia, Roma. *Zootaxa*, **4477** (1): 1–138. <https://doi.org/10.11646/zootaxa.4477.1.1>
- BANDEL K., 1982. Morphologie und Bildung der frühontogenetischen Gehäuse bei conchiferen Mollusken. *Facies*, **7**: 1–198, pls. 1–22. <https://doi.org/10.1007/BF02537225>
- BANDEL K. & HEIDELBERGER D., 2002. A Devonian member of the subclass Heterostrophina (Gastropoda) with valvatoid shell shape. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, **2002** (9): 533–550. <https://doi.org/10.1127/njgpm/2002/2002/533>
- BARCO A., AISSAOUI C., HOUART R., BONOMOLO G., CROCIETTA F. & OLIVERIO M., 2013. Revision of the *Ocenebrina aciculata* species complex (Mollusca: Gastropoda: Muricidae) in the northeastern Atlantic Ocean and Mediterranean Sea. *Journal of Molluscan Studies*, **84** (1): 19–29. <https://doi.org/10.1093/mollus/eyx039>
- BIELER R. & MIKKELSEN P.M., 1988. Anatomy and reproductive biology of two Western Atlantic species of Vitrinellidae, with a case of protandrous hermaphroditism in the Rissoacea. *The Nautilus*, **102** (1): 1–29.
- BIELER R., BALL A.D. & MIKKELSEN P.M., 1998. Marine Valvatoidea - comments on anatomy and systematics with descriptions of a new species from Florida (Heterobranchia: Cornirostridae). *Malacologia*, **40** (1-2): 305–320.
- BOUCHET P., ROCROI J.P., HAUSDORF B., KAIM A., KANO Y., NÜTZEL A., PARKHAEV P., SCHRÖDL M. & STRONG E.E., 2017. Revised classification, nomenclator and typification of gastropod and monoplacophoran families. *Malacologia*, **61** (1-2): 1–526. <https://doi.org/10.4002/040.061.0201>
- CECALUPO A. & GIUSTI F., 1989. Rinvenimenti malacologici a sud-ovest dell'Isola di Capraia (LI) - parte II. *Bollettino Malacologico*, **25** (1-4): 97–109.
- COLGAN D.J., PONDER W.F., BEACHAM E. & MACARANAS J., 2007. Molecular phylogenetics of Caenogastropoda (Gastropoda: Mollusca). *Molecular Phylogenetics and Evolution*, **42** (3): 717–737. <https://doi.org/10.1016/j.ympev.2006.10.009>
- COLL M., PIRODDI C., STEENBEEK J., KASCHNER K., LASRAM F.B.R., AGUZZI J., BALLESTEROS E., BIANCHI C.N., CORBERA J., DAILIANIS T. et al., 2010. The biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE*, **5**: e11842. <https://doi.org/10.1371/journal.pone.0011842>
- CROCIETTA F., POURSANIDIS D. & TRINGALI L.P., 2015. Biodiversity of sea slugs and shelled relatives (Mollusca: Gastropoda) of the Cretan Archipelago (Greece), with taxonomic remarks on selected species. *Quaternary International*, **390**: 56–68. <https://doi.org/10.1016/j.quaint.2015.02.061>
- DINAPOLI A. & KLUSMANN-KOLB A., 2010. The long way to diversity - Phylogeny and evolution of the Heterobranchia (Mollusca: Gastropoda). *Molecular Phylogenetics and Evolution*, **55** (1): 60–76. <https://doi.org/10.1016/j.ympev.2009.09.019>
- FUKUDA H. & YAMASHITA H., 1997. Two new species of the family Cornirostridae (Gastropoda: Heterobranchia: Valvatoidea) from the Seto Inland Sea, western Japan. *Yuriyagai*, **5**: 1–16.
- GEIGER D.L., MARSHALL B.A., PONDER W.F., SASAKI T. & WARÉN A., 2007. Techniques for collecting, handling, preparing, storing and examining small molluscan specimens. *Molluscan Research*, **27** (1): 1–50.
- GIANNUZZI-SAVELLI R., PUSATERI F., MICALI P., NOFRONI I. & BARTOLINI S., 2014. *Atlante delle conchiglie marine del Mediterraneo, vol. 5 (Heterobranchia)*. Edizioni Danaus, Palermo, pp. 1–111 with 41 unnumbered plates (figs. 1–363), appendix pp. 1–91.
- GRANATA-GRILLO G., 1877a. Contribuzione pella fauna dei molluschi del Mediterraneo. Catalogo delle conchiglie di Messina e dintorni. *Il Barth, Giornale di Medicina e Scienze Naturali*, **4** (2): 143–147.
- GRANATA-GRILLO G., 1877b. *Description de quelques especes nouvelles ou peu connues*. S. Marchese, Naples, 15 pp.
- HASEGAWA K., 1997. Sunken wood-associated gastropods collected from Suruga Bay, Pacific side of the central Honshu, Japan, with description of 12 new species. In Hiroshige K. (ed.), Deep-Sea Fauna and Pollutants in Suruga Bay. *National Science Museum Monographs*, **12**: 59–123.
- HASEGAWA K., 2017. Family Cornirostridae, in Okutani T. (ed.), *Marine Mollusks in Japan*, 2nd ed., 2 vols. Tokai University Press, Tokyo: 1060–1061, pl. 353.
- HASZPRUNAR G., SPEIMANN E., HAWE A. & HESS M., 2011. Interactive 3D anatomy and affinities of the Hyalogyrinidae, basal Heterobranchia (Gastropoda) with a rhipidoglossate

m, in CS. 1 sh, Capraia Island (Livorno, Italy), 30 m, in FC.

This is a fairly well known species, whose taxonomic position and anatomy were settled by Warén et al. (1993) and Haszprunar et al. (2011). Here we provide a description of the shell and operculum, in order to facilitate a comparison with *H. zibrowii*, the most similar species.

Description (based on the examined samples and the literature data)

Shell small (W up to 2 mm), depressed, valvatiform, thin and transparent (Fig. 8. A-H). Protoconch consisting of about 0.7-0.9 whorls, DP 215-260 µm, in most specimens 240 µm (12 measured shells). Protoconch smooth and expands regularly, with small nucleus, slightly intorted. Protoconch-teleoconch border without varix. Teleoconch of up to 2.3 slightly convex whorls. Spire relatively low. Last whorl rounded on periphery. Suture deep. Aperture prosocline, almost circular. Peristome sharp and discontinuous in parietal zone. Umbilicus deep and wide, with rounded edge. Surface smooth except for some growth lines more apparent in umbilical zone, flexuous in abapical part. Operculum corneous, circular, fitting aperture, transparent, multispiral, tightly coiled, with central nucleus (Fig. 8. I).

Remarks

As above reported, shells of *X. pellucida* generally differ from those of *H. zibrowii* in their depressed spire, wide

umbilicus, circular aperture and weak axial sculpture. However they can show a remarkable range of variability of some characters, and vary in shape from almost planorboid to relatively high-spired (Fig. 8. B, E, H). The aperture, often perfectly circular in frontal view, can be ovoidal in some specimens (Fig. 8B, E). The size of the protoconch, as well as the nucleus, also ranges widely (Fig. 8. A', D', G'), even in the same sample (e.g. 215-255 µm). *X. pellucida* is widespread throughout the Mediterranean Sea and the neighboring Lusitanian area, and, judging from the bibliography and present records, usually lives in shallow waters (0.5-40 m). Here we report that some live-taken specimens were obtained from relatively deep-waters (180 m, off Capri Island) (Fig. 8. G, H), which suggests this species has a wider bathymetric range than previously recognised.

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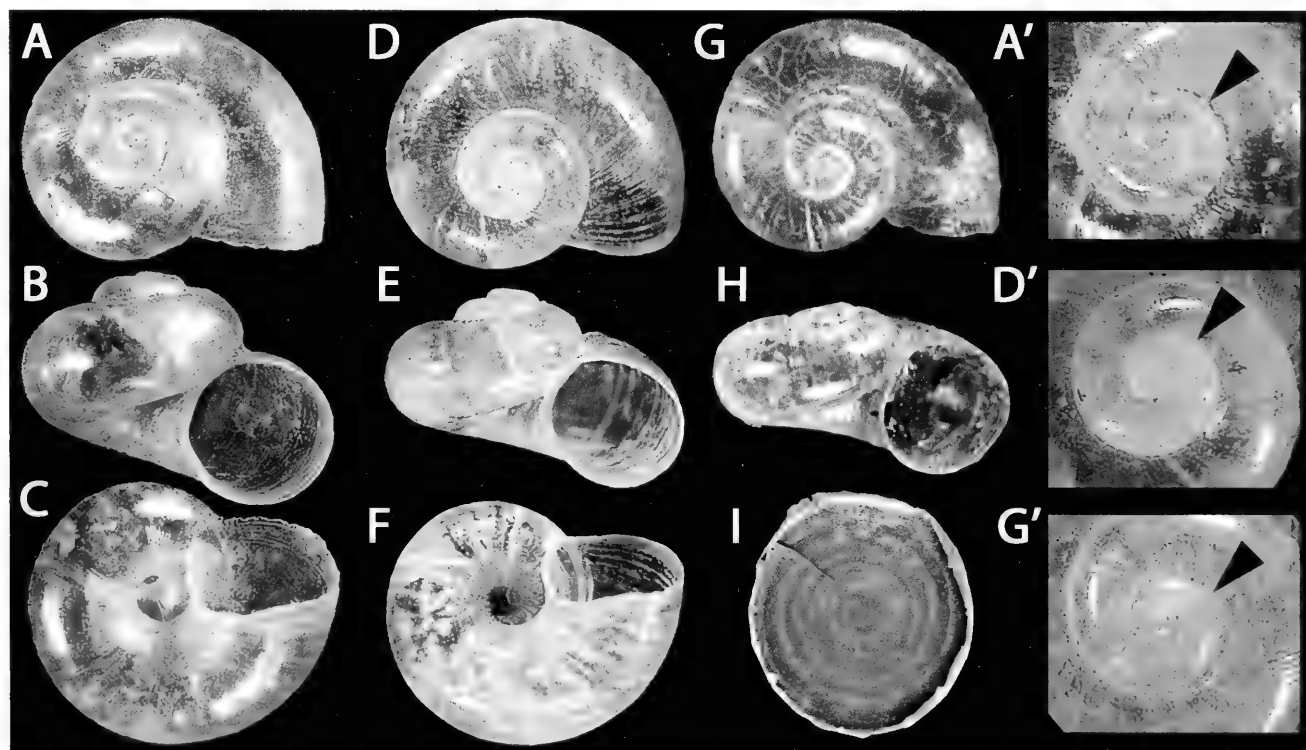


Fig. 8. *Xenoskenea pellucida*. **A-F.** Pantelleria Island (Italy) (SB), **A-C.** W 1.43 mm; **D-F.** W 1.40 mm; **G-H.** Capri Island (Italy), W 1.37 mm (CB); **I.** operculum, diameter 460 µm (modified from Warén et al., 1993: fig. 12). Arrows point the protoconch-teleoconch border.

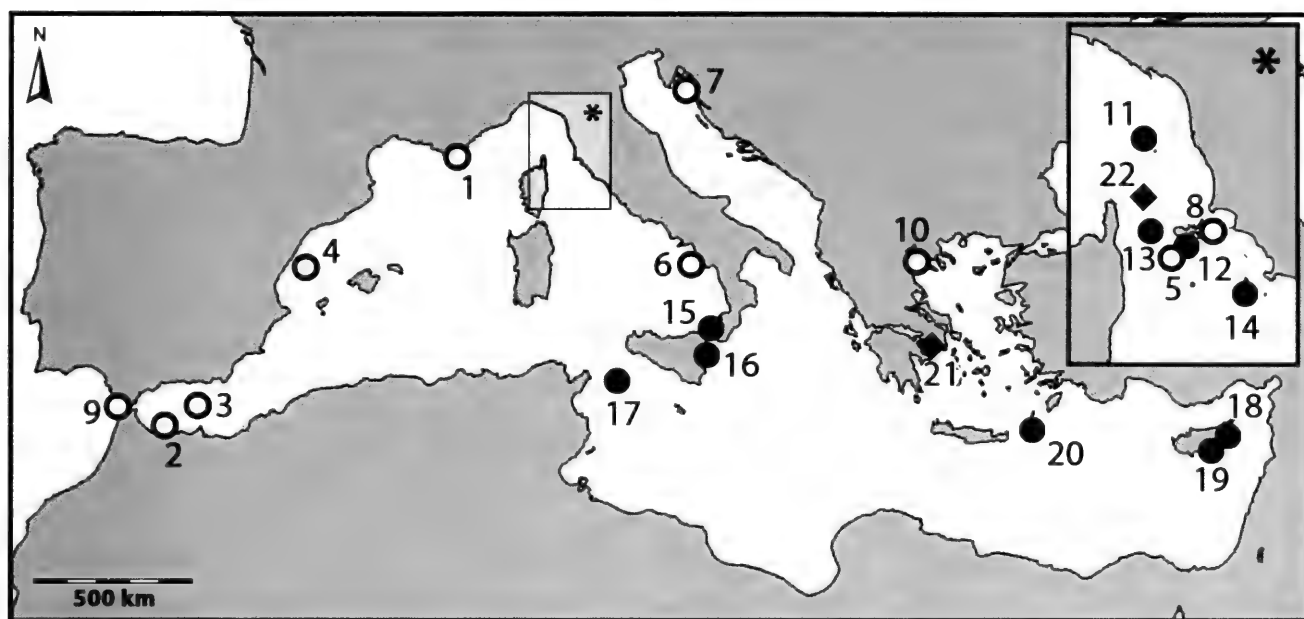


Fig. 7. *Hyalogyra zibrowii*. Known distribution. Empty dots (1-10): confirmed records from literature (records arranged in chronological order). Black dots: new records (11-20). Lozenges (21-22): records from literature (under other names). Localities: (1) Îles d'Hyères, France (Warén, Carrozza & Rocchini, 1997). (2) Cala Iris, Morocco (Tringali, 2001). (3) Isla de Alborán, Spain (Peñas et al., 2006). (4) Islas Columbretes, Spain (Oliver et al., 2012). (5) Pianosa island, Italy (Giannuzzi-Savelli et al., 2014). (6) Palinuro, Italy (Romani & Sbrana, 2016). (7) Krk island, Croatia (Romani & Sbrana, 2016). (8) Elba island, Italy (Scaperrotta et al., 2018). (9) Tarifa, Spain (Scaperrotta et al., 2018). (10) Epanomi (Greece) (Manousis et al., 2020). (11) Gorgona Island, Italy. (12) S Elba Island, Italy. (13) S Elba Island, Italy. (14) Giglio Island, Italy. (15) Messina, Italy. (16) Aci Castello, Italy. (17) Pantelleria Island, Italy. (18) Cape Greco, Cyprus. (19) Larnaca, Cyprus. (20) Karpathos Island, Greece. (21) Saronikos Gulf, Greece (Tenekides, 1989). (22) Capraia island, Italy (Cecalupo & Giusti, 1989).

cords could be explained as dead specimens transported from shallower waters (unlikely given the fragility of the shells), or could rather suggest a wider depth range than previously recognized. These deeper-water specimens appear to attain a larger size than shallow-water ones, have a stronger axial sculpture, a deeper and larger umbilicus, a more angulated aperture, and a constantly opaque appearance. The 2.2 mm shells figured in Scaperrotta et al. (2018) and reproduced here, have been incorrectly reported from 40 m depth, instead of 120 m depth (pers. obs.). "*Cyclostrema*" cfr. *laevigatum* Jeffreys in Griele, 1875 (sic!) recorded by Cecalupo & Giusti (1989) can be assigned to this latter morph. It should be noted that *Moelleria laevigata* Friele, 1876 is a synonym of *Skenea trochoides* (Friele, 1876), a distinctive species from the Northern Atlantic (Warén, 1991). Further studies, and possibly more complete material, are needed to establish if this morph represents another species.

Genus *Xenoskenea* Warén & Gofas, 1993.

Xenoskenea Warén et Gofas, 1993, 36(1): 10. Type species by original designation: *Skenea pellucida* Monterosato, 1874. Recent, Mediterranean Sea.

Currently the genus *Xenoskenea* includes one extant described species, another species is known from Japan but is yet undescribed (Haszprunar et al., 2011). They possess valviform, uninformative shells and can be diagnosed only by some external features of the animal, such as the posterior end of the foot having a single, slender metapodial tentacle, a pallial lobe, and a prom-

inent snout bearing two small oral tentacles. The radular teeth are arranged in the formula: $n+3+l+3+n$ (Warén et al., 1993).

Xenoskenea pellucida (Monterosato, 1874) (Fig. 8)

Material examined

1 sh, Livorno (Italy) (43°34'30.4"N; 10°16'27.5"E), 9 m, Attilio Pagli leg., 2018; 1 sh, Alghero (Sassari, Italy) (40°31'33.9"N; 8°19'40.1"E), 8 m, Luigi Giunchi leg., 1994; 2 shs, Lavezzi Island (Corsica, France) (41°20'03.7"N; 9°15'00.8"E), 32 m, Paolo Paolini leg., 2000; 1 sh, Ustica Island (Palermo, Italy) (38°41'51.9"N; 13°09'12.9"E), 50 m, Attilio Pagli leg., 2000; 5 shs, Aci Castello (Catania, Italy) (37°33'01.8"N; 15°09'26.1"E), 45 m, Stefano Palazzi leg., 1999, all in AP. 2 shs, Elba Island (Livorno, Italy) (42°43'25.5"N; 10°09'31.6"E), 40 m, Stefano Bartolini leg., V.2008; 4 shs, Pantelleria Island (Trapani, Italy) (36°46'02.4"N; 11°57'44.2"E), 40 m, Stefano Bartolini leg., VII.2007; Tarifa (Spain) (36°00'00.0"N; 5°36'30.0"W), 30 m, Stefano Bartolini leg., VII.2012, 2 shs; 4 shs, L'Île-Rousse (Corsica, France) (42°39'03.2"N; 8°55'46.4"E), 30 m, Stefano Bartolini leg., VI.2010; 4 shs, Castelsardo (Sassari, Italy) (41°00'45.4"N 8°43'11.0"E), 40 m, Stefano Bartolini leg., 30.VI.2008, all in SB. 2 shs, near Iskenderun (Turkey), 6 m; 5 spms, off Capri Island (Naples, Italy) (40°32'27.8"N 14°16'22.9"E), 180 m, all in CB. 8 shs, Sidi Youssef (Kerkennah Islands, Tunisia) (34°39'13.8"N 10°58'05.3"E), 0.5 m, Carlo Sbrana & Franco Siragusa leg., VIII.2010, in CS and FS; 1 sh, Capo Passero (Siracusa, Italy) (36°41'05.5"N; 15°09'14.6"E), 16

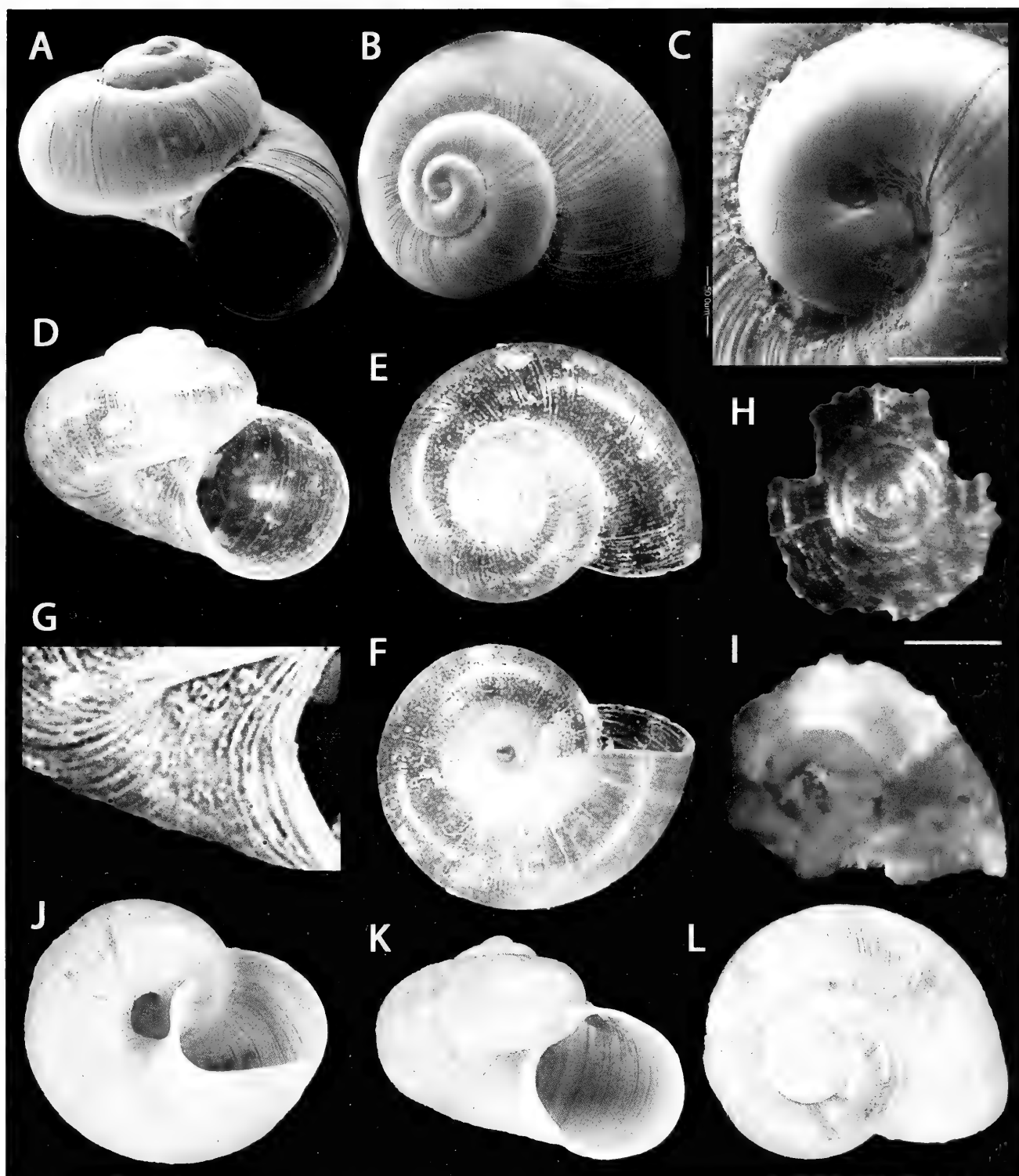


Fig. 6. *Hyalogyra zibrowii*. **A-I.** Karpathos Island (Greece) (PM). **A-G.** W 1.65 mm; **H.** operculum optical photograph (internal side); **I.** rehydrated specimen. **J-L.** off Elba Island (Italy), W 2.18 mm. Scale bars 100 µm (fig. 6. C) and 300 µm (fig. 6. H).

et al., 2012; Giannuzzi-Savelli et al., 2014; Romani & Sbrana, 2016; Scaperrotta et al., 2018; Manousis et al., 2021). Here its known range is extended to the Ionian Sea, Strait of Sicily, Southern Aegean Sea and Levantine Sea, showing a wider intra-Mediterranean distribution (Fig. 7). The habitat of *H. zibrowii* has not been well characterized, since most records are based on empty shells. Almost all records refer to shallow water sediments (2-40 m) in the infralittoral zone (the few exceptions are discussed below). The type material originated from fine sediments collected in a submarine cave (7

m), and the shells from Palinuro (AP & CS) were also found in similar sediments deposited on the bottom of submarine caves (less than 20 m). The other records come from coralligenous substrates. The live-collected specimens examined here were sampled at 1-2 m depth on a mixed bottom showing an overall absence of canopy algae, and the occurrence of scanty coralline algae, with some freshwater inflow. Further records are needed to ascertain the ecological preferences of this species. Some shells from Tuscan Archipelago have been collected at depths deeper than 100 m (Fig. 6. J-L). These re-

these atypical features were due to calcitic deposits of unclear origin. This explanation has not been accepted by Bandel & Heidelberger (2002) who considered such shells as belonging to different taxa (probably vetigastropods). Among the rich sample we examined, only typical specimens were detected. The only skeneimorph in the sample that had a comparable shell was *Akritogyra conspicua* (Monterosato, 1880). This latter species was dealt with by Warén et al. (1997) who recognized their close similarity to *H. amphorae*, and discussed their differences. Among the dozens of *A. conspicua* collected in the same sediments, a certain variability of the spire elevation and protoconch size could be noticed, partially overlapping with *H. amphorae*. Some high-spired shells of *A. conspicua* show strong similarity with the above-mentioned "atypical" *H. amphorae*, and might support Bandel & Heidelberger's (2002) opinion.

Genus *Hyalogyra* B.A. Marshall, 1988

Hyalogyra B.A. Marshall, 1988: 982. Type species by original designation: *H. expansa* Marshall, 1988. Recent, New Zealand.

Currently the genus *Hyalogyra* includes four extant species, all recorded from the Atlantic and Pacific Oceans. They possess uninformative shells and can be reliably diagnosed only by some anatomical characters, notably the radular morphology, the teeth being arranged according to the formula $n+(3-6)+1+(3-6)+n$.

Hyalogyra zibrowii Warén, 1997
(Fig. 6)

Material examined

1 sh, Palinuro (Salerno, Italy) (40°01'53.5"N 15°16'08.1"E), 18 m, Attilio Pagli leg., 09.IV.2018; 6 shs; off Gorgona Island (Livorno, Italy) (43°30'27.3"N 9°50'17.5"E), 220 m, Francesco Giusti leg. 1990, all in AP. 2 shs, Aci Castello (Catania, Italy) (37°33'09.6"N; 15°09'02.2"E), 15 m, in CB. 3 shs, Palinuro (Salerno, Italy) (40°01'33.5"N 15°16'04.8"E), 19 m, in CS, Carlo Sbrana leg. V.2004. 5 shs, Tarifa (Spain) (36°00'00.0"N 5°36'30.0"W), 30 m, Alessandro Raveggi leg., VII.2012. 1 sh, Pantelleria Island (Trapani, Italy) (36°46'02.4"N 11°57'44.2"E), 40 m, Stefano Bartolini leg., VII.2007; 2 shs, S Elba Island (Livorno, Italy) (42°43'25.5"N 10°09'31.6"E), 40 m, Stefano Bartolini leg., V.2008; 2 shs, Cape Greco (Cyprus) (34°57'40.2"N; 34°05'19.9"E), 30 m, Bartolini leg., V.2011; 4 shs, Larnaca (Cyprus) (34°54'09.1"N 33°38'54.7"E), 40 m, all in SB. 6 shs, Krk Island (Croatia) (44°59'20.3"N 14°36'58.5"E), 30 m, Stefano Bartolini leg., VIII.2008, in SB and CB. 1 sh, Giglio Island (Grosseto, Italy) (42°21'36.9"N 10°51'45.7"E), 40 m, in FC. 6 shs, off Elba Island (Livorno, Italy) (42°43'57.1"N 9°57'44.6"E), 120 m, Francesco Giusti leg., in FG. 5 spms and 9 shs, S Karpathos Island, (Dodecanese, Greece) (35°25'32.0"N; 27°09'19.9"E), 1-2 m, Pasquale Micali leg., VII.2017, in PM & AP. 2 shs, E Karpathos Island, (Dodecanese,

Greece) (35°33'36.0"N 27°12'26.9"E), 2 m, Pasquale Micali leg., VII.2017, in PM. 15 shs, S Karpathos Island, (Dodecanese, Greece) (35°25'32.0"N 27°09'19.9"E), 2 m, Franco Agamennone leg., VII.2017, in FA.

Description

Shell small (W up to 2.2 mm), skeneiform, thin and transparent (Fig. 6. A, B, D-F). Protoconch consisting of about 0.7-0.8 whorls, DP 230-255 µm, in most specimens 245 µm (12 measured shells) (Fig. 6. C). Nucleus small, slightly intorted, without evident sculpture. Rest of protoconch smooth and expands regularly. Protoconch-teleoconch border clear, without varix. Teleoconch consisting of up to 2.6 slightly convex whorls. Spire relatively low. Last whorl large, rounded on periphery. Suture quite deep. Aperture prosocline, subcircular, except in columellar zone where it is slightly angulate. Peristome sharp and discontinuous in parietal zone. Umbilicus deep, with rounded edge. Surface crossed by quite evident growth lines, more appreciable in umbilical zone (Fig. 6. G), and flexuous in abapical part. Fresh shells vitreous, otherwise opaque white. Operculum (Fig. 6. H) corneous, circular, fitting aperture, slightly concave, transparent, multispiral, tightly coiling and with central nucleus. Faint central tubercle on internal side present. Radula not examined. External features of the animal, except the presence of eye spots, could not be here described due to very poor state of preservation of rehydrated specimens (Fig. 6. I).

Remarks

H. zibrowii was described from empty shells, and was tentatively assigned to the genus based on similarities with other *Hyalogyra* species known at that time, although shell morphology is not a truly helpful character in this genus. Concerning the other species of Mediterranean Hyalogyrinidae, *H. amphorae* has a high-spired teleoconch, a complete peristome and an unmistakable protoconch. *X. pellucida* has a more flattened spire, a wider umbilicus, a more regularly circular aperture and a very faint axial sculpture. On the other hand, the protoconch shape and size in *H. zibrowii* and *X. pellucida* overlap (respectively 16 and 12 measured shells, see under the species descriptions for details), and the tightly coiled opercula are also very similar (Warén et al., 1993). Moreover, *H. zibrowii* differs from the congeneric species which have opercula consisting of regularly increasing whorls (Rubio et al., 1993; Warén & Bouchet, 1993; B.A. Marshall pers. comm., 23.XII. 2020). Albeit the opercular features are inconsistent with those reported in other congeneric species, a proper assessment of their taxonomic value is not possible in the absence of the diagnostic radular morphology. Thus, we prefer to maintain *H. zibrowii* in its current taxonomic position, even though close affinities with *Xenoskenea* are here reported. So far *H. zibrowii* has been recorded from few Mediterranean localities (Warén, Carrozza & Rocchini, 1997; Tringali, 2001; Peñas et al., 2006; Oliver

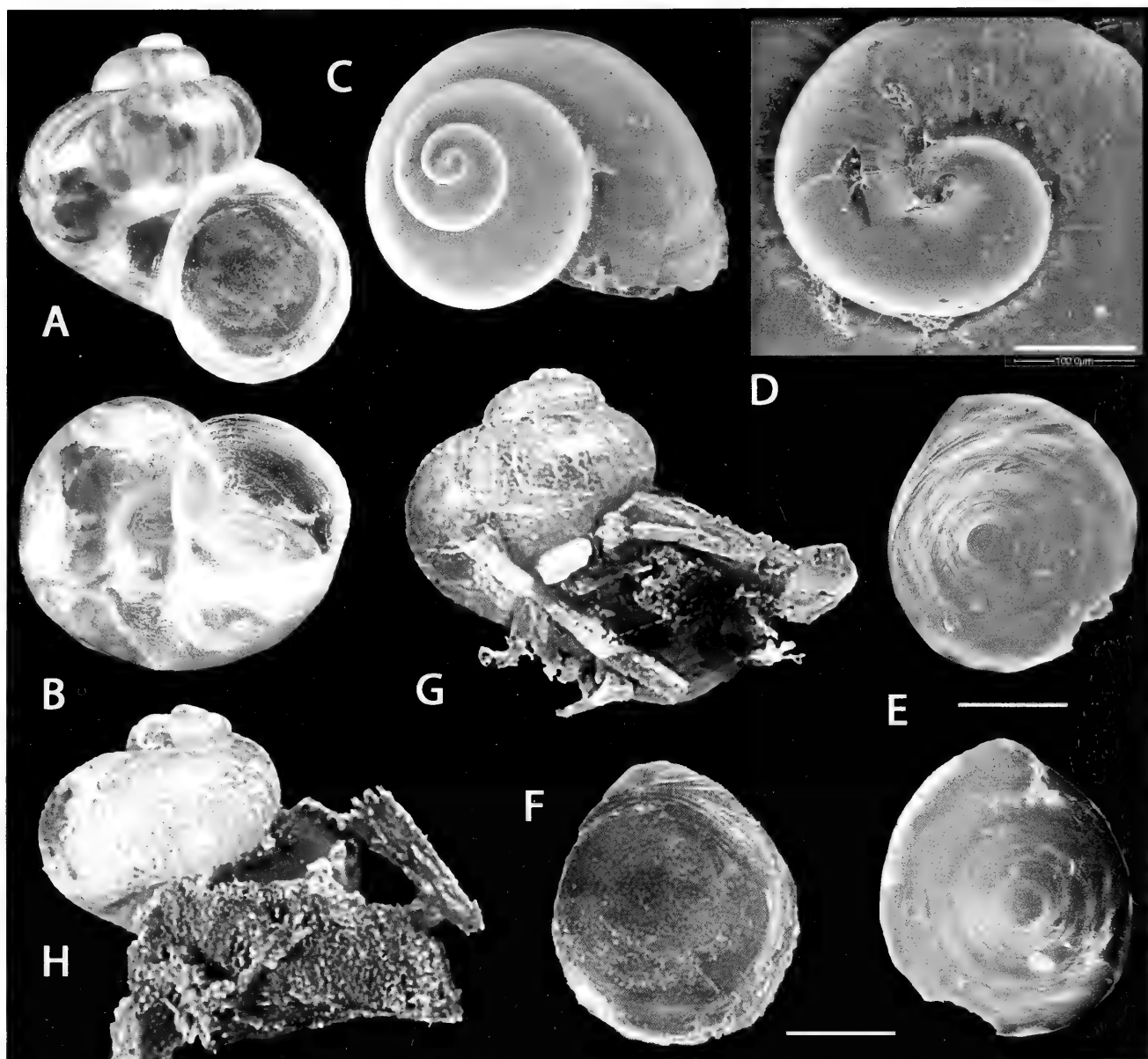


Fig. 5. *Hyalogyrina amphorae*, off Gorgona Island (Italy) (FG & LR). **A, B, F.** W 1.52 mm, **F.** operculum optical photograph (external side) (A, B. after Giannuzzi-Savelli et al., 2014, images by Stefano Bartolini); **C, D, E.** W 1.68 mm; **E.** operculum SEM photographs (upper: external side, lower: internal side). **G.** W 1.68 mm; **H.** W 1.70 mm. Scale bars 100 μ m (fig. 5D) and 300 μ m (figs. 5, E, F).

very thin, smooth and transparent. Operculum (**Fig. 5, E, F**) oval, corneous, yellowish and transparent, slightly concave, multispiral, with sub-central nucleus, consisting of about 4-5 regularly increasing whorls. Radula not examined. The external animal features not observed due to poor preservation of rehydrated specimens. Colour of animal seems to be yellow-light brown (Scaperrotta et al., 2018).

Remarks

H. amphorae was described from empty shells, and assigned to *Hyalogyrina* by virtue of the peculiar protoconch (Warén et al., 1997). The opercular features here examined are consistent with those of the genus (e.g. Marshall, 1988; Warén & Bouchet, 1993, 2001, 2009). Although the radular characters could not be observed, the protoconch, operculum and habitat (see below) strongly support its allocation in this genus. *Hyalogyrina*

amphorae shells were originally found in the mud inside an amphora collected at bathyal depths from a locality off the Tuscan coast. The authors supposed that the amphora harbored living specimens and suggested some hypotheses to explain how this particular environment could sustain them. They also noted that a single shell collected off Crete was found on wood. Most of the specimens here examined were found on sunken driftwood or firmly attached to small pieces of ligneous material (**Fig. 5, G, H**). As some other species of *Hyalogyrina* have been shown to live on wood (Marshall, 1988; Hasegawa, 1997), this is probably the preferred habitat of *H. amphorae*. *H. amphorae* is recorded so far from deep waters off the Tuscan and Cretan coasts, however a wider, probably discontinuous, distribution, due to bathymetrical and ecological preferences, can be expected. Warén et al. (1997) illustrated and discussed some shells of *H. amphorae* with a sturdier appearance and a skeineid-like regularly coiled protoconch, assuming that



Fig. 4. *Cornirostra pellucida*, Shallow Inlet, Victoria (Australia), W 1.30 mm (image by Platon Vafiadis, modified).

Gulf of Gabes, which is considered as an introduction hot spot (Ounifi Ben Amor et al., 2016). Nonetheless, the known biology of Cornirostridae, suggesting direct development or very short larval development (Fukuda & Yamashita, 1997), is hardly compatible with an anthropic introduction. Moreover, it seems that Cornirostridae species are generally cryptic and occur in specific environments; therefore the possibility of a native, undescribed species of *Cornirostra* cannot be excluded, pending the examination of additional material.

Family Hyalogyrinidae Warén & Bouchet, 1993

The family Hyalogyrinidae was introduced by Warén & Bouchet (1993) to include two genera: *Hyalogyrina* and *Hyalogyra*, both described by B. A. Marshall (1988) from deep sea sunken wood and originally assigned to Ske-neidae W. Clark, 1851, despite their peculiar anatomical characters. Later on Warén et al. (1993) established the new genus *Xenoskenea* Warén & Gofas, 1993 for a shallow-water Mediterranean species, and assigned it to this family. Subsequently further species were described from biogenic substrata and hydrothermal vents (Rubio et al., 1993; Warén & Bouchet, 1993, 2001, 2009; Hasegawa, 1997; Warén et al., 1997). Currently 12 extant species

are assigned to the family and classified in three genera (MolluscaBase eds., 2021c). Hyalogyrinidae have small, globular or depressed, featureless shells, with umbilicus and primarily heterostrophic protoconchs. The operculum is corneous, multispiral, with a central nucleus. The head has a tapering snout (often with appendages) and long cephalic tentacles. The pallial cavity contains a large gill. The rhipidoglossate radula, a key feature of the family, is diagnostic at the generic level. For further information refer to Haszprunar et al. (2011) who gave detailed anatomical accounts and summarized the taxonomic history, systematic position and evolutionary hypotheses concerning this family and related taxa. Currently three Mediterranean species, each within a different genus, have been placed in Hyalogyrinidae: *Hyalogyrina amphorae* Warén, Carrozza & Rocchini, 1997; *Hyalogyra zibrowii* Warén, 1997; and *Xenoskenea pellucida* (Monterosato, 1874). The first two are poorly known, as they were described only on shell characters.

Genus *Hyalogyrina* B.A. Marshall, 1988

Hyalogyrina B.A. Marshall, 1988: 984. Type species by original designation: *H. glabra* Marshall, 1988. Recent, New Zealand.

Currently seven extant species are assigned to the genus, all recorded from the Atlantic and Pacific Oceans in deep-water. The peculiar protoconch (smooth, with rapidly expanding whorls, and a very small and finely malleated nucleus) and the radular formula ($n+1+1+1+n$) are diagnostic for the genus.

Hyalogyrina amphorae Warén, Carrozza & Rocchini, 1997 (Fig. 5)

Material examined

100 shs and 23 spms, between Gorgona Island (Livorno, Italy) and Cape Corse (Corsica, France), 400-600 m, Francesco Giusti leg., in FG.

Description (based on the examined sample and partially adapted from the original description).

Shell small (W up to 1.9 mm), skeneimorph, transparent and glossy, fragile (Fig. 5. A-C). Spire high, quite variable, with early whorls not flattened. Protoconch (Fig. 5. D) consisting of about 0.7-0.9 whorls, DP 220-235 μ m, in most specimens 225 μ m. Nucleus small, sunken, intorted, with wrinkled sculptural pattern. Rest of protoconch smooth and expands rapidly. Protoconch I - protoconch II border not clearly visible; protoconch-teleoconch border clear, without varix. Teleoconch consisting of up to 3 convex whorls. Suture quite deep. Base simple, rounded, smooth. Surface smooth except for faint growth lines. Umbilicus rather narrow, deep and simple. Aperture oval with adapical side gently angulated. Peristome complete, simple and sharp. Periostracum

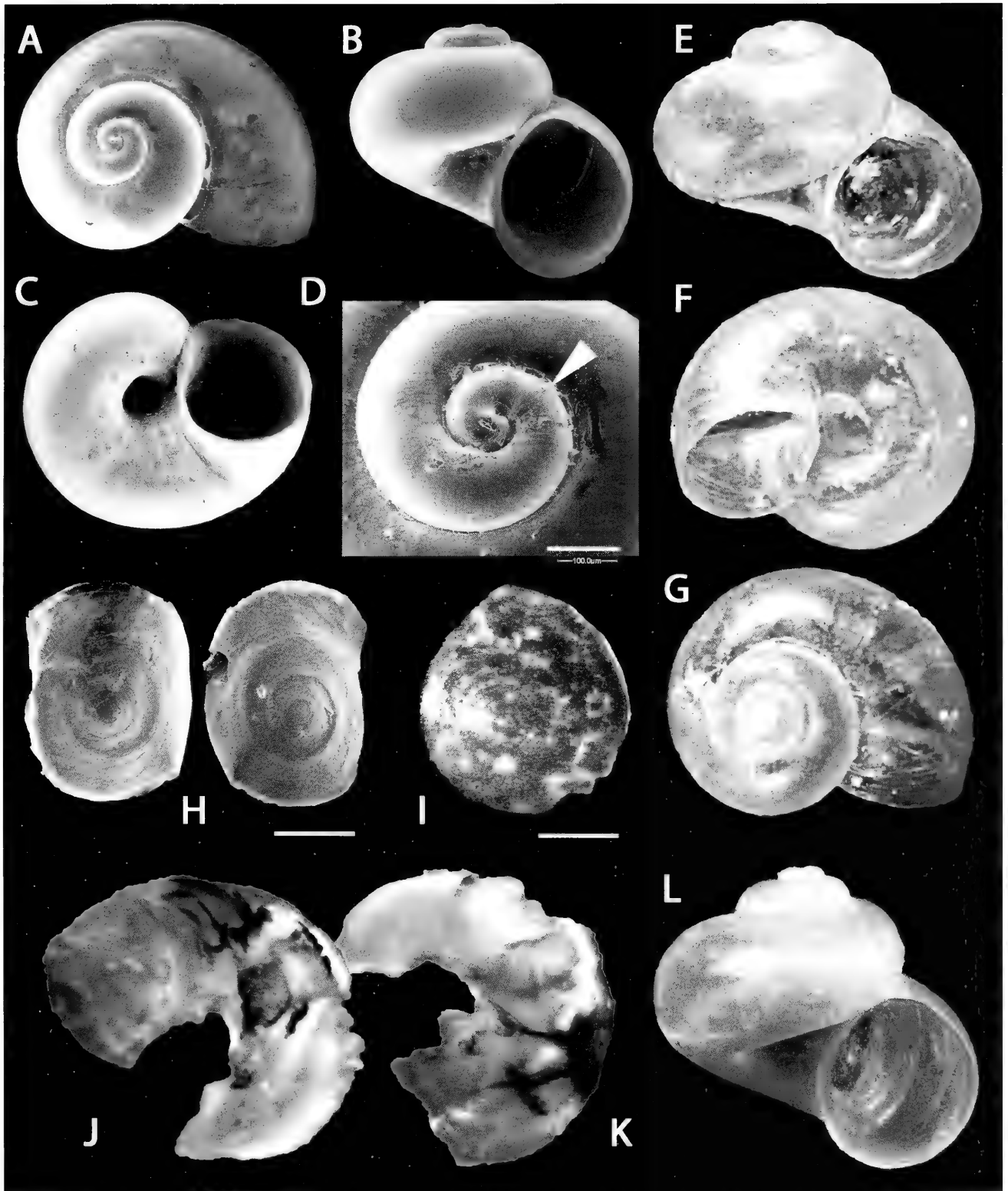


Fig. 3. *Cornirostra* spp. **A-K.** *Cornirostra* sp., Kerkennah Islands (Tunisia) (CB & LR); **A-D.** W 1.62 mm; **E-G.** W 1.67 mm. **H.** operculum SEM photographs, slightly distorted (left: external side, right: internal side), **I.** operculum optical photograph (external side). **J-K.** rehydrated specimen, **J.** ventral side, **K.** dorsal side. **L.** *Cornirostra pellucida*, Merimbula Lake, New South Wales (Australia) (AM C.354959), W 2.15 mm (image by Des Beechey, AM, modified). Scale bars 100 µm (fig. 3. D) and 300 µm (figs. 3. H, I). Arrow (fig. 3. D) points the protoconch-teleoconch border.

the status of *Cornirostra* sp. cannot be presently resolved. This species was collected in a shallow-water seagrass bed located in front of Sidi Fredj, NW coast of Chergui island, Kerkennah Islands, Tunisia, where it is assumed to live on leaves or more probably among rhizomes of *Posidonia oceanica* (L.) Delile. Similar shallow-water habitats are reported for the other live-collected *Cornirostra* (Ponder, 1990; Bieler et al., 1998; Vafia-

dis, 2016; Hasegawa, 2017). Despite careful examination of numerous samples stored in several collections originating from the Kerkennah Islands, the whole Gulf of Gabes and elsewhere in the Mediterranean Sea, no further specimens assignable to *Cornirostra* sp. were found. This record could be explained as an anthropic introduction from the Atlantic or Indo-Pacific regions, as the locality is very close to the port of Sfax, and close to the

quirements, together with the occurrence of *T. depressa* in the hypoxic rhizome layer of the *Posidonia* biocoenosis (see Holmer et al., 2003), might suggest that this latter species could have similar ecological requirements. Although the Capraia specimen of *T. rubiorolanorum* was found in an organically enriched environment, the higher frequency of this species among algae might instead suggest that it is not associated to hypoxic environments. However, further live material of both species is needed to confirm this hypothesis.

Genus *Cornirostra* Ponder, 1990

Cornirostra Ponder, 1990, 56 (4): 534-535. Type species by original designation: *Microdiscula pellucida* Laseron, 1954. Recent, Australia.

The genus *Cornirostra* was established by Ponder (1990) to accommodate two species described by Laseron (1954) and assigned on shell features to the genus *Microdiscula* Thiele, 1912 (currently Orbitestellidae Iredale, 1917). The anatomy of several specimens corresponding to the type material of the two nominal taxa (*M. pellucida* and *M. fragilis*) was thoroughly examined and they turned out to be conspecific. This species possesses highly variable and featureless skeneiform shells, but it can be clearly recognized by its anatomical features which place it near Valvatidae. *C. pellucida* was reported as widespread throughout Australian coasts, Mauritius and Midway Islands, suggesting a wide Indo-Pacific distribution (Ponder, 1990). A second species of *Cornirostra* was described from Florida (Western Atlantic) and shares the same head-foot features as *C. pellucida* (Bieler et al., 1998), while a third species from Cuba (Western Atlantic) was assigned to the genus on shell characters alone (Rubio et al., 2013). Finally, an undescribed species was recorded from Japan (Hasegawa, 2017).

Cornirostra sp.
(Fig. 3; Table 1)

Material examined

Cornirostra sp.: 10 spms, Sidi Fredj (Kerkennah Islands, Tunisia) (4°41'54.2"N 11°07'39.2"E), 1 m, in *Posidonia* bed, Christiane Delongueville & Roland Scaillet leg., 07.X.2010, in CB.

Description

Shell small (W up to 1.9 mm), skeneiform, with relatively high spire although H/W ratio < 1 (Fig. 3. A-C, E-G; Table 1). Periphery rounded, thin, transparent, perfectly smooth except few hardly visible growth lines.. Early whorls quite flattened. Protoconch consisting of about 0.75 whorls, DP 165-185 µm, in most specimens 180 µm (Fig. 3. D). Nucleus small, slightly sunken, with gently wrinkled sculptural pattern, rest of protoconch smooth. Protoconch I - Protoconch II border not clearly visible.

Protoconch-teleoconch border clear, without varix: just slight labial thickening is present. Teleoconch consisting of 2.2-2.7 convex whorls. Suture quite deep, not channeled. Base simple, rounded, smooth. Umbilicus deep and simple, without umbilical keel. Aperture oval with adapical side gently angulated, peristome simple and sharp. Periostracum very thin and transparent, easily detached. Some shells show repaired fractures, resulting in irregularly coiling spires. Operculum oval, corneous, yellowish and transparent, slightly concave, multispiral, with sub-central nucleus, of about 4-5 regularly increasing whorls (Fig. 3. H, I). Radula not examined.

External soft parts: no living specimens were examined, but external appearance of animal was inferred from rehydrated specimen (Fig. 3. J, K), although due to poor preservation only some features were recognizable. Visceral mass yellow/light brown with irregular black patches and stripes cover pallial region apparently corresponding to pigmented zones of head and pallial wall. Two dark pigmented strips in antero-dorsal position could be longitudinally-pigmented cephalic tentacles (Fig. 4) (Ponder, 1990; Bieler et al., 1998; Vafiadis, 2016; Hasegawa, 2017).

Remarks

The shells, as well as the operculum and the animal chromatic pattern, of *Cornirostra* sp. are almost identical to those of two other congeneric species. *Cornirostra pellucida* has highly variable shells ranging from almost planispiral to trochiform (Ponder, 1990), but high-spired shells are substantially comparable in any respect (Fig. 3. L). The only differences seem to be the larger protoconch (217 µm vs. 170-185 µm) and the larger maximum size (2.30 mm vs. 1.88 mm) in *C. pellucida*. *Cornirostra floridana* Bieler & Mikkelsen, 1998 has quite uniform shells, virtually identical to those of *Cornirostra* sp., the only apparent differences being a more acute spire and a larger maximum size (2.1 vs. 1.88 mm). The third species of the genus, *Cornirostra lenticulata* Rubio, Rolán & Fernández-Garcés, 2013, clearly differs for the lenticular-shaped shell. Two other Mediterranean marine valvatoideans have shells similar to *Cornirostra* sp., sharing a more or less high spire, but they can be easily distinguished by the following features: *Hyalogyrina amphorae* has a more acute apex and its protoconch has a peculiarly shaped nucleus, moreover it lives in deeper waters. *Hyalogyra zibrowii* has a larger protoconch, a different apertural outline and a coarser axial sculpture (see below). Although the small number of examined specimens of *Cornirostra* sp. does not allow reliable evaluation of shell shape, it seems quite uniform, except for slight variability in spire height. *Cornirostra* sp. shells might superficially resemble those of some freshwater Valvatidae and Hydrobioidea but the protoconch, opercular and animal chromatism are clearly different. Moreover, the finding of living animals excludes the possibility that they are freshwater snails washed ashore. Due to the lack of properly preserved material

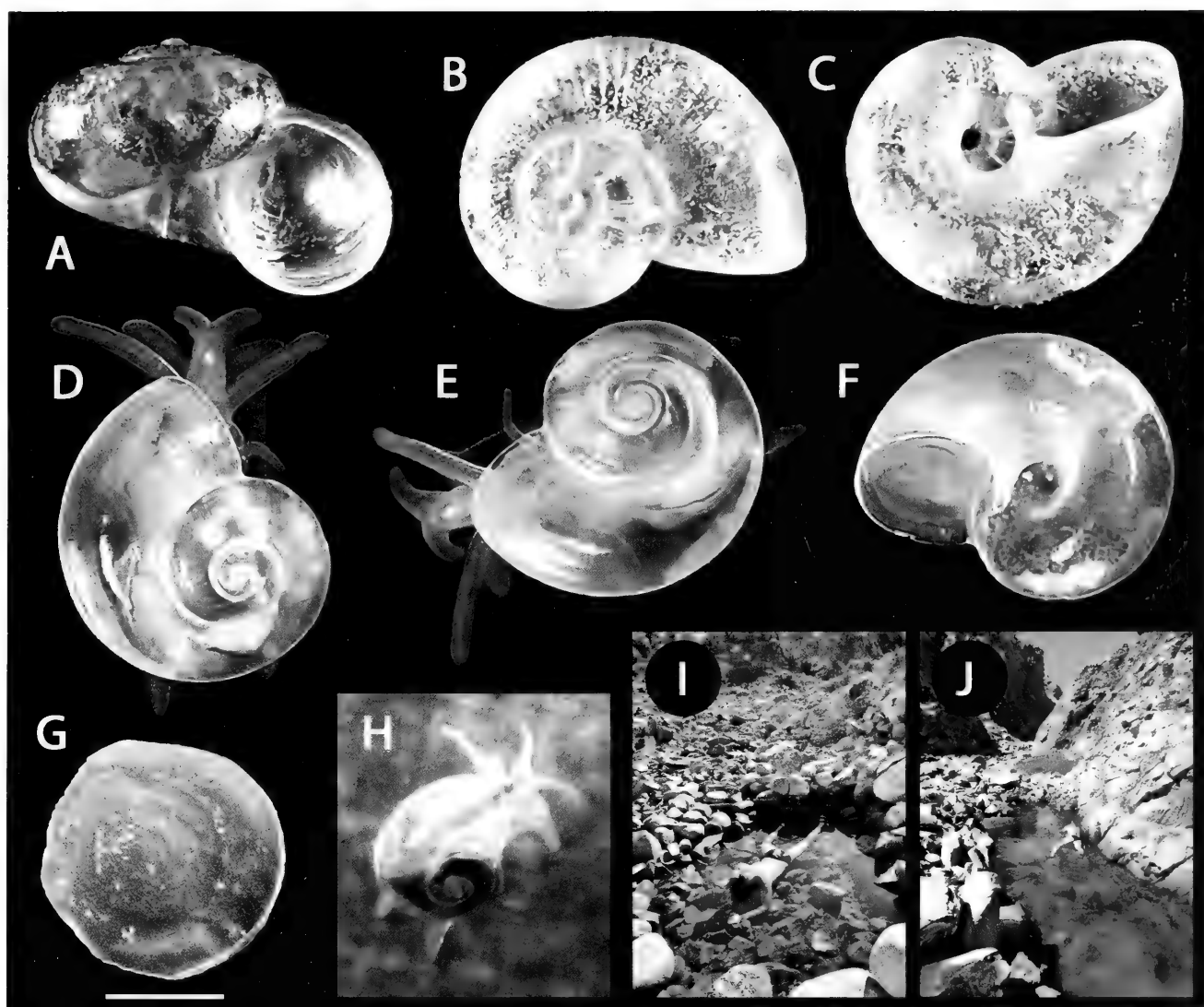


Fig. 2. *Tomura rubiorolanorum*. **A, D–F.** W 1.46 mm, Brusnik Island (Croatia) (RS); **B, C.** W 1.57 mm, Brusnik Island (Croatia) (RS); **G, H.** W 1.38 mm, Capraia Island (Italy) (LR); **I, J.** habitat, Brusnik Island. Scale bar 300 µm (fig. 2. G).

Remarks

This species was recently described from empty shells and was only tentatively assigned to *Tomura*, as in cornirostrids generic placement relies mainly on animal and radular features. The finding of two living specimens enabled the examination of the external animal and operculum which appear very similar to those of *T. depressa* and confirm the previous generic placement. Apparently it differs from *T. depressa* in lacking a clearly distinguishable pigmented mantle organ. The size of the pallial tentacle is comparable to that reported for *T. depressa* by Warén et al. (1993) and *Tomura bicaudata* (Ponder, 1990). The new records suggest that *T. rubiorolanorum* is widespread throughout the central Mediterranean Sea and extend its distribution to the Adriatic Sea. As most of the previously known material came from sediments collected in submarine caves or from coralligenous substrates. It was speculated that the species dwelt in shaded habitats such as rock crevices, shallow caves or interstitial gravel bottoms. However, the discovery of live specimens provided more detailed information. The specimen from Capraia Island was sampled on gravel with some pebbles and a moderate

organic enrichment at 10 m depth, together with *Hedylopsis spiculifera* (Kowalevsky, 1901) and *Microhedyle* sp. The Adriatic specimens were sampled in the sediment and among algae in the shallow pools of Brusnik Island, in 20–60 cm depth (Fig. 2. I–J). Although the habitat of the species is unclear, it seems to occur more frequently on algae. Ecological data on the genus *Tomura* are scanty. *T. bicaudata*, *Tomura himeshima* Fukuda & Yamashita, 1997 and *Tomura yashima* Fukuda & Yamashita, 1997 are typically reported as an intertidal to shallow-subtidal species occurring in hypoxic environments under stones (Pilsbry & McGinty, 1946; Fukuda & Yamashita, 1997). Shells of *T. depressa* have been reported from a few decimeters to 50 m depth (Romani & Sbrana, 2016), but the few live specimens known have been collected between 2 and 32 m depth on sandy bottoms (Warén et al., 1993) or between *Posidonia* rhizomes (Mbazio et al., 2020). Warén et al. (1993) suggested that the alleged rarity of live *T. depressa* is due to their precise habitat being currently unknown; the same might account for the scarcity of live individuals of *T. rubiorolanorum*. The adaptation of the better-known species of *Tomura* to hypoxic environments might suggest that Mediterranean *Tomura* could have similar ecological re-

ly the *O. depressa* type material should be considered lost. However, the Monterosato Collection includes numerous samples received from many nineteenth and early twentieth centuries malacologists and collectors. A sample of *O. depressa* (MCZR-M-11182) has been discovered in the Monterosato general Collection. It consists of 25 shells, not fully adult and mostly suffering from Byne's disease, but undoubtedly matching *T. depressa* as currently conceived (Fig. 1. A-C, G-I). This sample is provided with a handwritten label by Monterosato, stating: "*Oxystele depressa* Granata 1877. Pal! e Trap. Mess. (Granata) anche Algeria" [*Oxystele depressa* Granata 1877. Palermo! and Trapani, Messina (Granata) also Algeria] (Fig. 1. K). Though not accompanied by a Granata-Grillo original label, nor explicitly labeled by Monterosato as originating from him, Granata-Grillo's name is reported in brackets after the localities, as well as after the name of the species, and finally the *O. depressa* type locality is among those written on the label. This suggests that it is a gift by the author to Monterosato. Several samples retrieved in the Monterosato Collection in similar condition (i.e. purportedly a gift to Monterosato by the authors) have been designated as syntypes, e.g. *Rissoa tenuicostata* G. Seguenza, 1876; *Rissoa peloritana* Aradas & Benoit, 1874; *Rissoa sororcula* Granata-Grillo, 1877; *Cylichna laevisculpta* Granata-Grillo, 1877 (Crocetta et al., 2015; Amati & Smriglio, 2016; Appolloni et al., 2018; Amati et al., 2019, 2020). Since the original type material is lost and a holotype has not been mentioned in the original description, the specimens of *T. depressa* in Monterosato's collection should be considered as syntypes.

Tharsiella tinostomoides was described from specimens collected in the Gulf of Tunis. The authors compared it with several other species, but not *O. depressa*, evidently unaware of the latter. The authors' good description makes this taxon recognizable, however, the holotype, stored in MNHN, was illustrated by only a poor drawing and is figured here (Fig. 1. D-E, J), confirming Oliverio's (1983) synonymy. Warén et al. (1993) revised the systematic position of *T. depressa* and described some aspects of the anatomy. We have little to add to their redescription except that the size of the pallial tentacle seems to be quite variable. It is reported as minute by Warén et al. (1993), conversely Mbazios et al. (2020) figured a specimen with a very long pallial tentacle similar to those of two Japanese species (Fukuda & Yamashita, 1997). This character could be linked to intra-specific variability or depend on the stage of maturity. Warén et al. (1993) also noticed the presence of the presence of some spiral ridges on the earlier teleoconch whorl of scattered shells, but they regarded this character as variable and without taxonomic value. Here we report a shell possessing spiral treads over the first 1.5 whorls of the teleoconch. At the beginning these are stronger and irregularly spaced, then become more regular, weaker and numerous (about 30). Though the last part of the teleoconch is broken, the other shell characters, such as the closed umbilicus, overall spire outline and protoconch features (smooth, DP 145 µm),

are comparable to those of *T. depressa* (Fig. 1. L). However, we prefer not to assign it unequivocally to the latter, pending the examination of further material. This well-known species is recorded throughout the Mediterranean Sea and the nearby Atlantic Ocean.

Tomura rubiorolanorum Romani & Sbrana, 2016 (Fig. 2)

Material examined

T. rubiorolanorum: 10 shs, for details see Romani & Sbrana (2016). 1 spm, Capraia Island (Livorno, Italy) (43°00'54.6"N 9°49'26.0"E), 10 m, Joachim Langeneck leg., 31.III.2017, in LR. 1 spm and 7 shs, Brusnik Island (Croatia) (43°00'23.6" N; 15°48'04.0" E), 0.2-0.5 m, Rino Stanić leg., IX.2020, in LR & RS. 1 spm, Brusnik Island (Croatia), Rino Stanić legit, VIII.2015, in RS.

Emended description

Shell very small (W up to 1.6 mm), globose-depressed, wider than high, rather thin, transparent and glossy (Fig. 2. A-C). Teleoconch whorls almost perfectly smooth, with only weak growth lines. Suture indistinct and shallow; "false suture" visible in fresh specimens. Last whorl regularly rounded and slightly descending. Spire flattened, outline evenly convex, aperture almost circular. Columella regularly curved, slightly flared and thickened. Umbilicus open, simple, narrow and deep. Protoconch heterostrophic, consisting of 0.9-1.2 apparently smooth whorls, but with very delicate and irregular sculpture in nuclear zone, visible at high magnification. For detailed description see Romani & Sbrana (2016). Operculum (Fig. 2. G) circular, thin, transparent, multi-spiral, slightly concave, with central nucleus, composed of about 3-4 regularly increasing whorls, colour pale amber. Radula not examined. External morphology (inferred from brief direct observations and photographs) (Fig. 2. D-E, H): head-foot uniformly translucent white. Foot large and broad with parallel lateral margins, anterior end bifurcated into two rather long and pointed processes, posterior end with a deeply concave margin produced into two tail-like processes of unequal length. Snout long, with well-developed tentacle-like oral lobes, buccal mass brownish. Cephalic tentacles long, slender. Eyes minute, lying medially at the base of the cephalic tentacles. Posterior pallial tentacle tiny and delicate. Visceral and pallial structures partially visible through the transparent shell: in Tyrrhenian specimen mid-dorsal strip of light brown pigment noticeable (possibly anterior digestive tract). Pectinate gill barely visible. Penis not observed. Pallial cavity without evident pigmentation. Brown visceral mass occupying early whorls. Some further details of the visceral mass were observed in the Adriatic specimen, including light-brown digestive gland interspersed with small black dots (Fig. 2. F) and presence of cluster of small white spheres (possibly developing oocytes) (Fig. 2. D). Animal active and glides rapidly.

without any formal description (*nomen nudum*). In the following year this taxon was described and consequently validated, but *Tomura*, despite the peculiar external features of the animal, was demoted to a sub-genus of *Vitrinella* C. B. Adams, 1850 (Pilsbry & McGinty, 1946, 60: p. 15). Its taxonomic position in *Vitrinella*, already questioned, was ruled out by Bieler & Mikkelsen (1988), who briefly discussed the species in relation to vitrinellids, under the binomen *Tomura bicaudata* but refrained to assign it to any family. Ponder (1990), examined in detail the radula and external anatomy of *Vitrinella bicaudata*, which turned out to be similar to *Cornirostra pellucida* (Laseron, 1954), and subsequently regarded *Tomura* as a valid genus belonging to Cornirostridae. A few years later a second species, the Mediterranean *Oxystele depressa* Granata-Grillo, 1877, was included in the genus by Warén et al. (1993). Other species were subsequently described or transferred to *Tomura*, which currently includes 12 extant species (MolluscaBase eds., 2021b).

***Tomura depressa* (Granata-Grillo, 1877)**
(Fig. 1)

Oxystele depressa Granata-Grillo, 1877a: 146; 1877b: 9.
Tharsiella tinostomoides Fekih & Gougerot, 1977: 224-225, pl. 1, fig. 3-5.

Material examined

Oxystele depressa: 25 syntypes (Monterosato coll. ex Granata-Grillo MCZR-M-22227/S), type locality: Messina, Sicily (Italy).

T. depressa: more than 150 shs, see Romani & Sbrana (2016) for details.

Tomura cf. *depressa*: 1 sh, Linosa Island (Pelagian Archipelago, Agrigento, Italy) (35°51'59.6"N 12°53'04.2"E), 60 m, Franco Agamennone leg., VIII.2017, in LR.

Remarks

Oxystele depressa was described, with no accompanying illustrations, from the strait of Messina and rarely cited in the subsequent malacological literature, until Oliverio (1983, 1985, 1988) who summarized its nomenclatural history, assigned this species to the genus *Tharsiella* Bush, 1897, and added new data on its distribution and habitat. He also synonymized *T. tinostomoides* with *O. depressa* although without a direct comparison of the type material of both taxa, which, in fact, was never adequately illustrated. The type material of *O. depressa* was not discussed by Oliverio (1983), and was considered unknown by Warén et al. (1993). The Granata-Grillo malacological collection no longer exists, consequent-

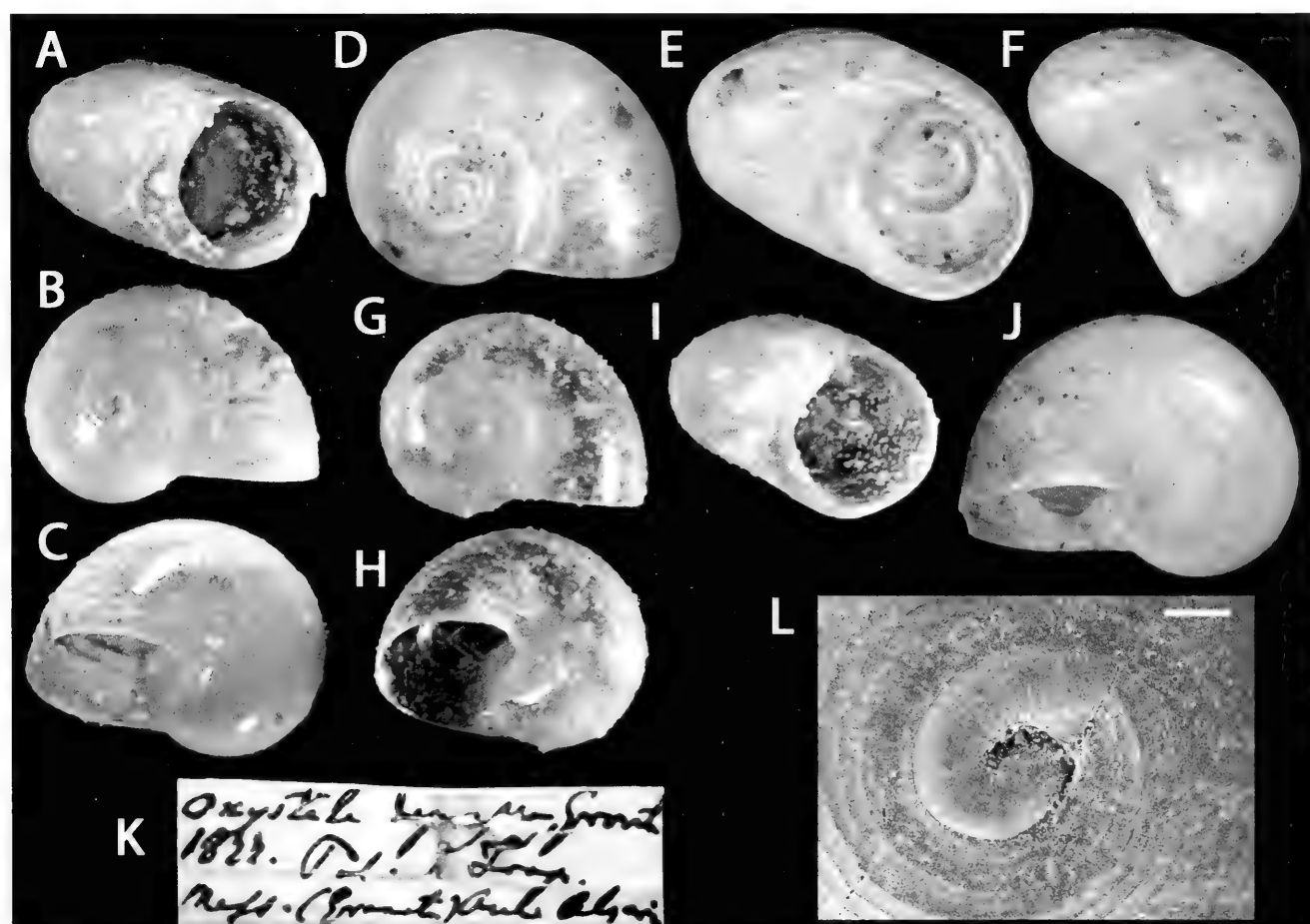


Fig. 1. *Tomura depressa*. **A-C.** *Oxystele depressa* syntype, Monterosato coll. ex Granata-Grillo coll., W 1.20 mm, Messina (Italy) (MCZR-M-11182); **D-F.** *Tharsiella tinostomoides* holotype, 1.40 mm, Khéreddine (Tunisia) (MNHN-IM-2000-31687); **G-I.** *Oxystele depressa* syntype, Monterosato coll. ex Granata-Grillo coll., W 1.00 mm, Messina (Italy) (MCZR-M-11182); **K.** *Oxystele depressa* label; **L.** *Tomura* cfr. *depressa*, W 1.00 mm, Linosa Island (Italy) (LR). Scale bar 50 µm (Fig. 1. L).

Fernández-Garcés & Rolán, 2011), but this character is often hardly noticeable or obscured by direct development. For this reason, the generic or even familial placement of the species is mainly based on anatomical and radular features. Marine Valvatoidea are currently represented in the Mediterranean Sea by five species belonging to the families Cornirostridae Ponder, 1990 (two species) and Hyalogyrinidae Warén & Bouchet, 1993 (three species). With the possible exception of *Tomura depressa* (Granata-Grillo, 1877) and *Xenoskenia pelucida* (Monterosato, 1874) (Warén et al., 1993), their distribution, anatomy and taxonomy are poorly known. This is due to their apparent rarity, hardly accessible habitats, small size, poorly characterized shells, and lack of anatomical information. The present paper is a contribution to increase the knowledge of the representatives of this superfamily.

Material and methods

Material examined was collected from bioclastic sea beds by scuba diving, by the manual washing/brushing of seagrass and algae, or obtained through sorting by-catch of commercial trawlers. In order to analyse the radular features, dried preserved specimens were rehydrated in distilled water added with a small quantity of neutral detergent, and subsequently tissues were dissolved in a 10% solution of sodium hydroxide (NaOH). Unfortunately, due to the poor state of preservation, in all specimens examined the radula collapsed and no useful radular extraction was obtained. Comparisons were done with material figured in recent studies and samples from several localities (see below). Analysed material is currently preserved in institutional and private collections (in the latter case relevant specimens will later be deposited in public museums). Shells were examined through Lomo MBC-10 stereomicroscope and photographed with a Canon EOS 400D camera, measurements were carried out by means of an eyepiece micrometer. Protoconch whorls were counted according to Verduin (1977). Shells and opercula, after air drying and mounting on SEM stubs, were examined with both XL30 and Quanta 200 SEM in the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) - University of Vigo, and Vega3-Tescan SEM in Senckenberg am Meer, Marine Research Division (Wilhelmshaven). Updated taxonomy and nomenclature used follow MolluscaBase (2021) except where otherwise stated.

Abbreviations and acronyms

Institutional and private collections: AM - Australian Museum (Sydney, New South Wales, Australia); AP - Attilio Pagli collection (Empoli, Italy); CB - Cesare Bogi collection (Livorno, Italy); CS - Carlo Sbrana collection (Livorno, Italy); FA - Franco Agamennone collection (Pescara); FC - Francesco Chiriaco collection (Livorno, Italy); FG - Francesco Giusti collection (Livorno, Italy);

FS - Franco Siragusa collection (Livorno, Italy); LR - Luigi Romani collection (Capannori, Italy); MCZR - Museo Civico di Zoologia di Roma (Rome, Italy); MNHN - Muséum national d'histoire naturelle (Paris, France); PM - Pasquale Micali collection (Fano, Italy); RS - Rino Stanić collection (Split, Croatia); SB - Stefano & Maria Bartolini collection (Firenze, Italy).

Morphometrics: DP - protoconch maximum diameter; H - shell maximum height (in mm); W - shell maximum width (in mm).

Others: leg. - collector; SEM - scanning electron microscope; sh(s) - empty shell(s); spm(s) - live collected specimen(s).

Systematics

Subclass Heterobranchia Burmeister, 1837
 Infraclass "Lower Heterobranchia"
 Superfamily Valvatoidea Gray, 1840

Family Cornirostridae Ponder, 1990

The family Cornirostridae was established by Ponder (1990) to include two genera: *Tomura* Pilsbry and McGinty, 1946 and the new genus *Cornirostra* Ponder, 1990. Later Warén et al. (1993) added *Noerrevangia* Warén & Schander, 1993. Bieler et al. (1998) redefined on morphological grounds the family, which currently includes 15 recent species and has a worldwide distribution (MolluscaBase eds., 2021a). Cornirostridae have small, depressed-trochiform, usually smooth and umbilicate shells with a heterostrophic protoconch (character often not clearly visible). The operculum is circular, multi-spiral, with a central nucleus. The head has a bilobed snout, long cephalic tentacles and an external penis on the right side. A posterior pallial tentacle arising from the mantle is present. The foot is long with bifid anterior and posterior ends. The pallial cavity contains a large gill. The radula has nine teeth in each row, with two pairs of lateral and two pairs of marginal teeth (Ponder, 1990; Warén et al., 1993). Molecular data have confirmed Cornirostridae as belonging to the Heterobranchia (Colgan et al., 2007; Dinapoli & Klussmann-Kolb, 2010). Currently two species of Cornirostridae, both belonging to the genus *Tomura*, have been recorded in the Mediterranean Sea, the long-known *Tomura depressa* (Granata-Grillo, 1877) and the recently described *Tomura rubiorolanorum* Romani & Sbrana, 2016 (Romani & Sbrana, 2016 and references herein).

Genus *Tomura* Pilsbry & McGinty, 1946

Tomura Pilsbry & McGinty, 1946, 60(1): 15. Type species by monotypy: *Vitrinella (Tomura) bicaudata* Pilsbry & McGinty, 1946; Recent, Florida.

Pilsbry & McGinty (1945 pl. 2, fig. 9) illustrated a supposed new species and genus of vitrinelliform gastropod from Florida under the name *Tomura bicaudata* but

Remarks on the Mediterranean marine Valvatoidea (Gastropoda: Heterobranchia)

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Abstract

Marine Valvatoidea are characterized by very small size and uninformative shells, making their taxonomy depending chiefly on the animal. As a consequence, this group is still scarcely known and is in need of critical revision. In this contribution, the distribution of Mediterranean marine Valvatoidea (families Cornirostridae and Hyalogyrinidae) is revised based on newly collected material. Live individuals of *Tomura rubiorolanorum*, *Hyalogyrina amphorae* and *Hyalogyrina zibrowii* are reported for the first time, allowing the discussion of the ecological requirements of these species and the description of their opercula and the features of the head-foot. Conversely, several live-collected specimens of an unidentified species of the genus *Cornirostra* are reported for the Kerkennah Islands, Tunisia, but bad preservation of the animal did not enable a specific attribution. It might either represent the introduction of a non-indigenous species, or an undescribed native one.

Key words

Cornirostridae, Hyalogyrinidae, Mediterranean Sea.

Riassunto

I Valvatoidea marini sono caratterizzati da dimensioni molto piccole e conchiglie poco caratterizzate, perciò la loro tassonomia si basa principalmente su i caratteri dell'animale. Di conseguenza, questo gruppo è ancora poco conosciuto e necessita di una revisione critica. In questo contributo, la distribuzione dei Valvatoidea marini del Mediterraneo (famiglie Cornirostridae e Hyalogyrinidae) viene rivista sulla base di nuovo materiale. Per la prima volta sono riportati individui raccolti viventi di *Tomura rubiorolanorum*, *Hyalogyrina amphorae* e *Hyalogyrina zibrowii*, permettendo così la discussione dei requisiti ecologici di queste specie e la descrizione dei loro opercoli e di alcuni caratteri della regione cefalopedale. Inoltre, diversi esemplari raccolti viventi di una specie non identificata del genere *Cornirostra* sono riportati per le isole Kerkennah, Tunisia, ma la cattiva conservazione dell'animale non ha permesso un'attribuzione specifica. Essi potrebbero rappresentare l'introduzione di una specie non indigena o appartenere a una specie nativa non descritta.

Parole chiave

Cornirostridae, Hyalogyrinidae, Mar Mediterraneo.

Introduction

Mediterranean marine molluscs have been thoroughly investigated over three centuries in countless studies, resulting in the vast fauna currently known (Coll et al., 2010). Nevertheless, the real magnitude of molluscan diversity from this area remains far from adequately assessed (Oliverio, 2003). This is particularly true for small-sized species which are considered rare, easily overlooked, or hard to study and identify (Geiger et al., 2007). They include the great majority of undescribed/undetected molluscan taxa on a global scale (e.g.: Albano et al., 2011; Middelfart et al., 2016). In the Mediterranean Sea, dozens of species have been described or newly recorded during recent decades (Sabelli et al., 2014 and herein). A further reassessment of Mediterranean molluscs will also benefit from an increase in integrative taxonomic works, some of which have already revealed a previously unexpected diversity in several

groups (e.g. Barco et al., 2013; Aissaoui et al., 2016; Aissaoui et al., 2017). Among the groups of poorly known Mediterranean micromolluscs are the marine representatives of the Valvatoidea Gray, 1840. This superfamily belongs to the so-called "Lower Heterobranchia" grade, and is chiefly based on the freshwater Valvatidae Gray, 1840, but includes also some small marine families (Bouchet et al., 2017). The Valvatoidea are anatomically characterized, within the "Lower Heterobranchia", by having a snout, a pallial tentacle, an external penis and the radula has at least five teeth in each row (sometimes rhipidoglossate-like), among other anatomical features (Bieler et al., 1998; Ponder, 1998 and references therein; Haszprunar et al., 2011). The shells of valvatoideans are quite featureless, ranging from trochoid to discoidal. A morphological character, distinguishing them from "skeneiform-vitrinelliform" vetigastropods and caenogastropods, is the slightly hyperstrophic protoconch (Bandel, 1982; Warén, 1992; Bieler et al., 1998; Rubio,

- (Gastropoda: Arcaeogastropoda) del Senese: specie nuove o poco conosciute. *Bollettino Malacologico*, **22** (1-4): 85–90.
- SPADINI V., 1990. Il genere *Conus* (Gastropoda: Neogastropoda) nel Pliocene senese. *Bollettino Malacologico*, **25** (9-12): 315–328. (1989).
- SPADINI V., 2006. Il genere *Clanculus* Monfort, 1810 (Gastropoda: Trochidae) nel Pliocene senese (Toscana, Italia). *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano*, **147** (3): 211–237.
- WESSELINGH F. P. & POWER R., 2011. De fossiele schelpen van de Nederlandse kust II. Patellogastropoda en Vetigastropoda (deel 1). *Spirula*, **383**: 129–142.

specimens. It is uncommon, in the Pliocene, to find environments geologically representative of those suitable for the life of these molluscs. They live on rocky shores where the shells are destroyed by wave action before they can be preserved and this is undoubtedly the major cause of the rarity of their fossilized remains. Indeed, despite the countless studies on the Tuscan Pliocene malacofauna, from the nineteenth century to date, the only reports on specimens from the same localities reported here are those of Chirli (2004) and Forlì et al. (2004). There are currently no reports of patellids for other Tuscan Pliocene localities; in the area here considered, *P. caerulea* is relatively common while *P. alessiae* is rare. Our data on these rare Pliocene gastropodes, increasing knowledge of their temporal evolution in European marine waters, without however resolving some questions on the correct identification of Pliocene species.

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References

- ANDREOLI G. & MARSILI S., 1997. Una nuova specie di Trochide dal Pliocene della Toscana. *World Shells*, **20**: 19–21.
- BORGHI M. & VECCHI G., 2003. La Malacofauna Plio-Pleistocenica del torrente Stirone (PR). Parte IV. Trochidae (fine)-Coloniidae-Tricoliidae-Turbinidae-Scissurellidae-Patellidae-Acmaeidae. *Parva Naturalia*, **5** (2): 71–108.
- CEULEMANS L., VAN DINGENEN F. & LANDAU B., 2016. The lower Pliocene gastropods of Le Pigeon Blanc (Loire-Atlantique, Northwest France). *Patellogastropoda and Vetigastropoda*. *Cainozoic Research*, **16** (1): 51–100.
- CHIRLI C., 2004. *Malacofauna Pliocenica Toscana*. Vol. 4. *Archaeogastropoda*. Carlo Chirli Ed., Arti Grafiche BMB, Firenze, 198 pp.
- CUERDA BARCELÓ J., 1987. *Molluscos Marinos Y Salobres del Pleistoceno Balear*. Publ. Caja de Baleares 'Sa Nostra', Palma de Malloca, 421 pp.
- DI GERONIMO I., 2012. *I Molluschi del terrazzo tirreniano: considerazioni paleoecologiche*, 70–74 in Rosso A., Sanfilippo R., Di Geronimo I. & Bonfiglio L. (Eds). Libro guida all'escursione Acquedolci e Capo Milazzo (ME). Giornate di Paleontologia XII Edizione - Catania, 24–26 Maggio 2012. Tipografia dell'Università, Catania, 84 pp.
- DELL'ANGELO B. & FORLÌ M., 1995. Rinvenimento di piastre anomale di *Chiton saeniensis* Laghi, 1984 (Mollusca: Polyplacophora). *Bollettino Malacologico*, **31** (1–4): 77–80.
- FORLÌ M., DELL'ANGELO B., CIAPPELLI F. & TAVIANI M., 2003. A new species of Haliotidae (Mollusca, Vetigastropoda) in the Italian Pliocene. *Bollettino Malacologico*, **38** (9–12): 149–154. (2002).
- FORLÌ M., DELL'ANGELO B., MONTAGNA P. & TAVIANI M., 2004. A new large Patella (Mollusca: Patellogastropoda) in the Pliocene of Mediterranean Basin. *Bollettino Malacologico*, **40** (1–4): 3–10.
- GLIBERT M., 1949. Gastéropodes du Miocène moyen du Bassin de la Loire, Parte 1. *Mémoire de l'Institut Royal des Sciences Naturelles de Belgique*, **2** (30): 1–240.
- HENRIQUES P., DELGADO J. & SOUSA R., 2017. Patellid Limpets: An overview of the biology and conservation of keystone species of the rocky shores. In Ray S. (ed.) *Organismal and Molecular Malacology*. Croatia: Intech, pp. 71–95.
- LAGHI G.F., 1984. Sorprendente densità di *Chiton saeniensis* n. sp. in sabbie gialle plioceniche dei dintorni di Serre di Rapolano (Siena). *Bollettino del Museo Regionale di Scienze Naturali, Torino*, **2** (2): 555–564.
- LANDAU B., MARQUET R. & GRIGIS M., 2003. The Early Gastropoda (Mollusca) of Estepona, south Spain. Part 1: Vetigastropoda. *Palaeontos*, **3**: 1–87.
- LECOINTRE G., 1952. Recherches sur le Néogène et le Quaternaire marins de la côte atlantique du Maroc. *Service Géologique, Notes et Mémoires*, **99**: 173 pp., 28 pls.
- MALATESTA A., 1960. Malacofauna Pleistocenica di Grammichele (Sicilia). *Memorie per servire alla Carta Geologica d'Italia*, **12**: 1–196.
- MANGANELLI G., SPADINI V. & MARTINI I., 2010. Rediscovery of an enigmatic Euro-Mediterranean Pliocene nassariid species: *Nassarius crassiusculus* Bellardi, 1882 (Gastropoda: Nassariidae). *Bollettino della Società Paleontologica Italiana*, **49** (3): 195–202.
- MARTÍN-GONZÁLEZ E., VERA-PELÁEZ J.L., CASTILLO C. & LOZANO-FRANCISCO M.C., 2018. New fossil gastropod species (Mollusca: Gastropoda) from the upper Miocene of the Canary Islands (Spain). *Zootaxa*, **4422** (2): 191–218.
- MARTINI I., ALDINUCCI M., FORESI L. M., MAZZEI R. & SANDRELLI F., 2011. Geological map of the Pliocene succession of the northern Siena basin (Tuscany, Italy). *Journal of Maps*, 193–204.
- MECO J., KOPPERS A.A.P., MIGGINS D.P., LOMOSCHITZ A., & BETANCORT J., 2015. The Canary Record of the Evolution of the North Atlantic Pliocene: New 40Ar/39Ar Ages and Some Notable Palaeontological Evidence. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **435**: 53–69.
- MONEGATTI, P., RAFFI, S., 2001. Taxonomic diversity and stratigraphic distribution of Mediterranean Pliocene bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **165**: 171–193.
- MURRAY A., 1857. Notice of a marked variety of *Patella vulgata* (proposed to be named var. *intermedia*), found in Guernsey and Jersey (from Information communicated by Dr. Knapp). *The Annals and Magazine of Natural History*, **19** (2): 211–213.
- PASINI G., GARASSINO A. & DAMARCO P., 2018. Report of brachyuran crabs (Crustacea, Decapoda) from the Pliocene of Borgomanero, Novara (Piedmont, NW Italy). *Natural History Sciences. Atti Società italiana Scienze naturali Museo civico Storia naturale Milano*, **5** (2): xx–xx.
- POPPE G.T. & GOTO Y., 1991. *European Seashells*. Vol. I. *Polyplacophora, Caudofoveata, Solenogastrea, Gastropoda*. Wiesbaden, Verlag Christa Hemmen, 352 pp.
- POWELL A.W.B., 1973 The patellid limpets of the world (Patellidae). *Indo-Pacific Mollusca*, **3** (15): 75–206.
- RUGGERI G. & BUCCHERI G., 1968. Una malacofauna Tirreniana dell'Isola di Ustica (Sicilia). *Geologica Romana*, **7**: 27–58.
- SACCO F., 1897. *I molluschi dei terreni terziarii del Piemonte e della Liguria*. Parte XXII. *Gasteropoda (fine), Amphineura, Scaphopoda*. Carlo Clausen, Torino, 150 pp.
- SPADINI V., 1986. Contributo alla conoscenza dei Trochidae

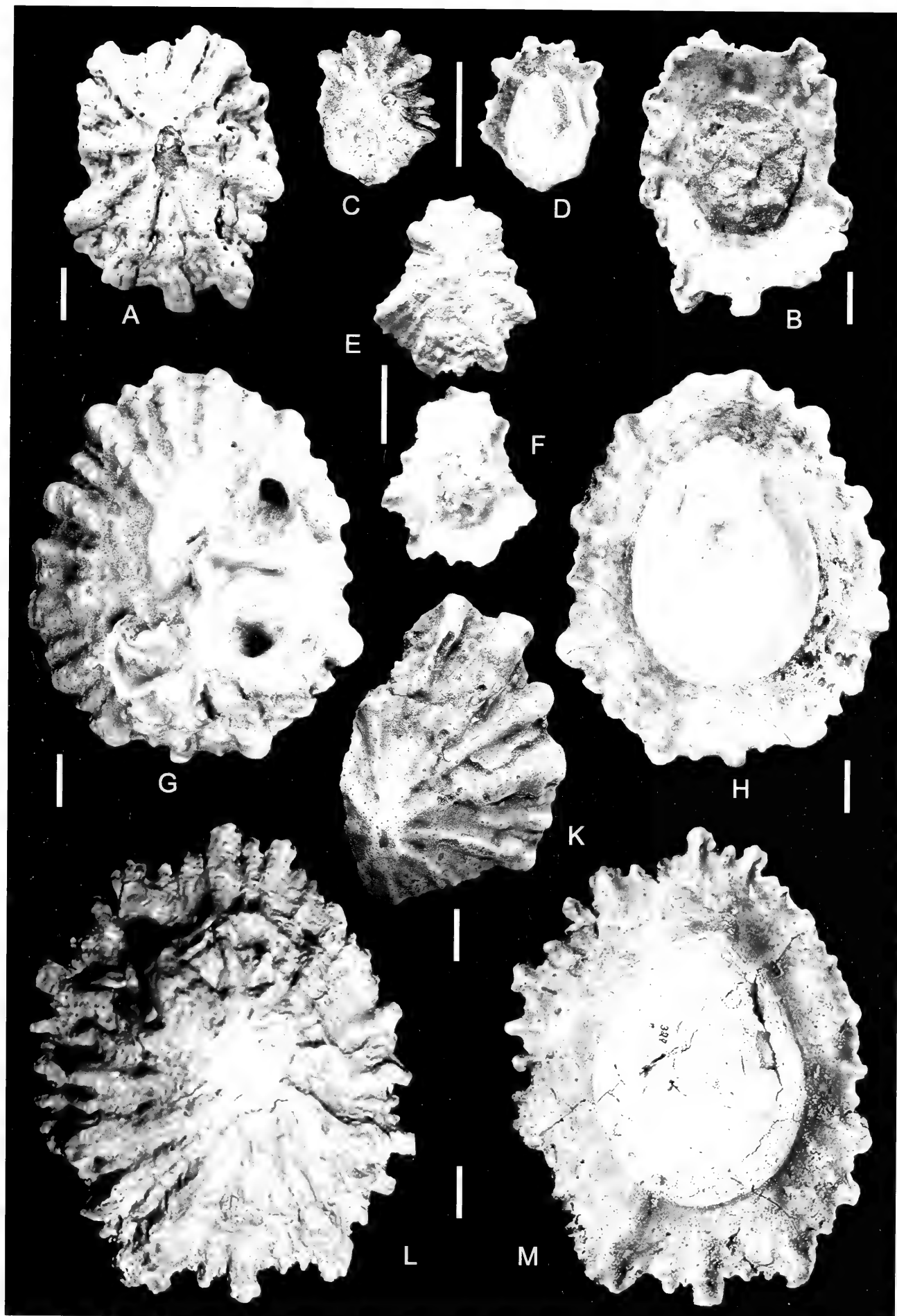


Fig. 5. *Patella alessiae* Forli et al., 2004, "Stroncoli" (Siena, F036B) Pliocene. **A, B.** adult sp., Paratype MZB 40656b, apical and ventral view, L 55, D 44, H 15; **C, D.** juvenile sp., apical and ventral view, L 15, D 11.8, H 2.5; **E, F.** juvenile sp., apical and ventral view, L 24, D 20, H 2; **G, H.** adult sp., apical and ventral view, L 75, D 60.4, H 35; **K.** adult sp., large fragment, apical view, L 59, D 42.2, H 15; **L, M.** adult sp., apical and ventral view, L 92, D 75, H 28. Scale bar 10 mm.

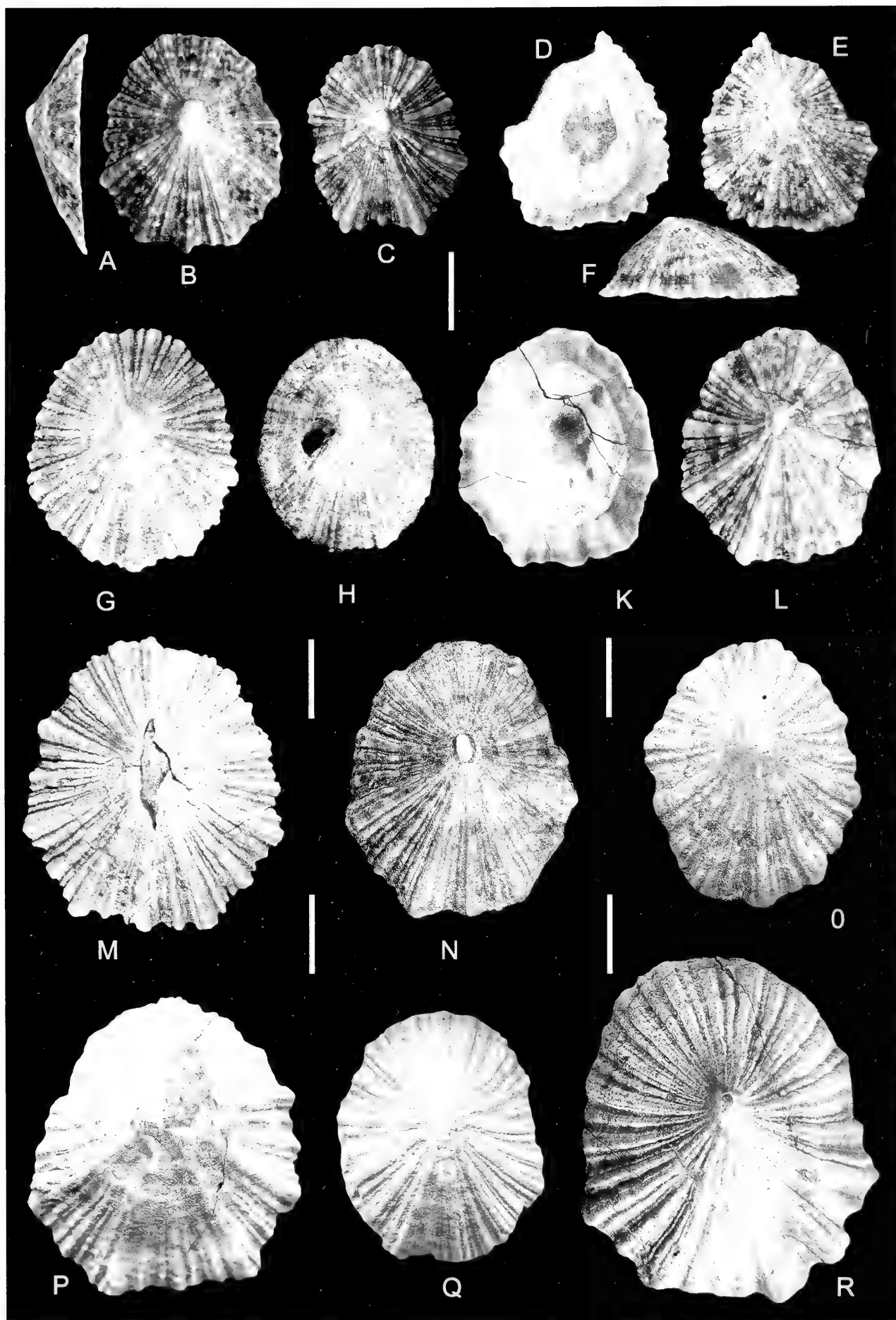


Fig. 4 *Patella caerulea* Linnaeus, 1758, "Stroncoli" (Siena, F036B) Pliocene. **A, B.** adult sp., lateral and apical view, L 28, D 23.8, H 7.6; **C.** juvenile sp., apical view, L 24.4, D 19.3, H 8; **D-F** adult sp., ventral, apical and lateral view, L ND, D 22.6, H 10.6; **G.** adult sp., apical view, L 31, D 27, H 9.8; **H** adult sp., apical view, L 27.4, D 22.6, H 8.4; **K, L.** adult sp., ventral and apical view, L 30.2, D 26.2, H 9.5; **M.** adult sp., apical view, L 37.4, D 33, H 10.5; **N.** adult sp., apical view, L 38, D 33.5, H ND; **O.** adult sp., apical view, L 34, D 27.5, H ND; **P.** adult sp., apical view, L 38, D 33.5, H ND; **Q** adult sp., apical view, L 36.4, D 30, H ND; **R.** adult sp., apical view, L 40.4, D 37, H ND. Scale bar 10 mm.

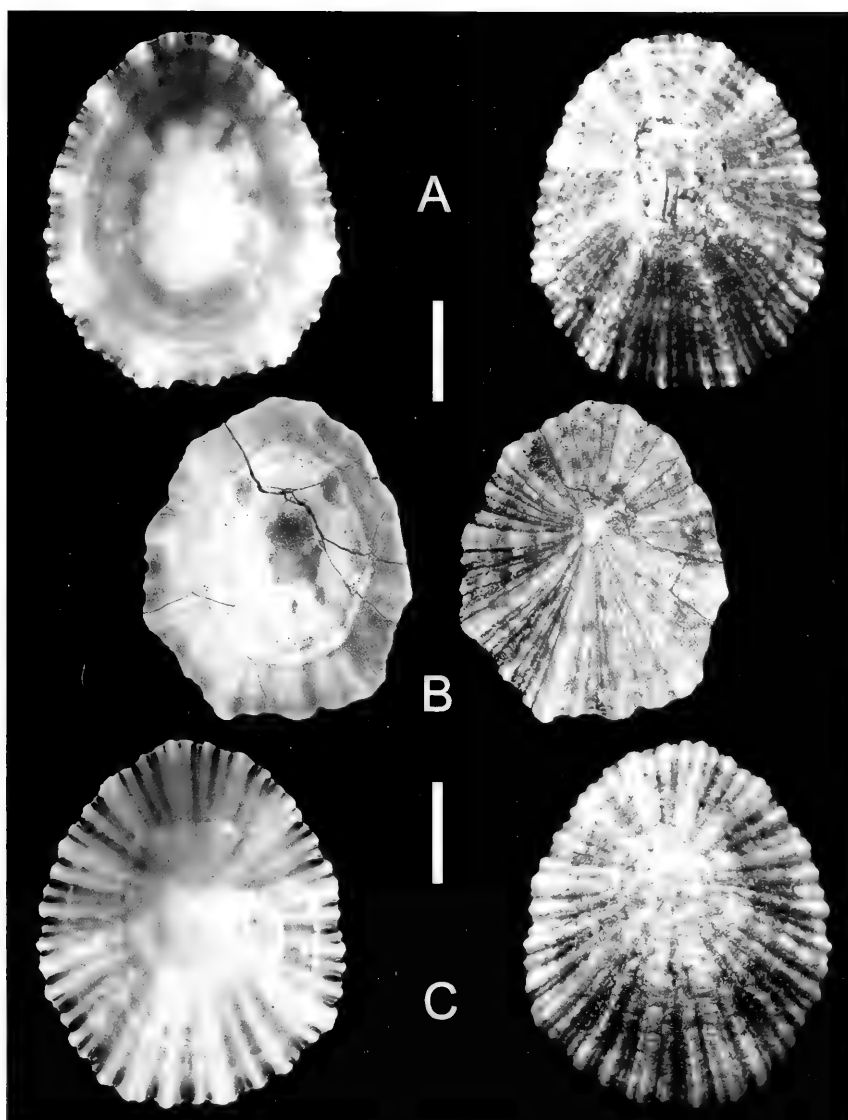


Fig. 3. *Patella caerulea* Linnaeus, 1758. **A.** Bosa (Oristano, V112C) recent, adult sp., L 35.4, D 29.4, H 8.3; **B.** "Stroncoli" (Siena, F036B) Pliocene, adult sp., ventral and apical view, L 30.2, D 26.2, H 9.5. *Patella depressa* Pennant, 1777. **C.** Malaga (Spain) (V002G) recent, adult sp., L 36.4, D 31, H 9.4. Scale bar 10 mm.

merous ribs (B. Landau personal communication, Forli, 2021). In our opinion they are very similar to specimen of *Patella ambroggii* Leconte, 1952, from the Pliocene of Morocco (Lecointre, 1952, Forli et al., 2004, fig. 4, i) and from the Pliocene of Canary Islands (Meco et al., 2015, appendix 2, d) now named *Patella tintina* Martín-González & Vera-Peláez (in Martín-González et al., 2018). These authors describing *P. tintina* from the upper Miocene (Tortonian) of Fuerteventura, (Canary Islands), proposed into bibliographic reference of their new species, some other specimens illustrated in Meco et al. (2015, appendix 2, a, b, c, g) before identified how *P. ambroggii*. Definitive identification on material from Estepona is further hampered by the worn preservation, and, at the moment, we can go no further than to say they belong within the *P. tintina* - *P. ambroggii* - *P. alessiae* - *P. ferruginea* group.

P. alessiae can be separated from *P. tintina* by its greater number of primary ribs, its lesser height and its more star-shaped basal profile (Martín-González et al., 2018). The discovery of some juvenile specimens allowed us to describe the ontogenetic development of *P. alessiae*. One of the small specimens figured (Fig. 5 E-F) resemble *P. caerulea* morphotype *stellata* Bucquoy, Dautzen-

berg & Dollfus, 1886 from which it is distinguished, with some difficulty, in having a longer shell, a more marked spatula and impression of the mantle edge; the other one is a typical, despite small, *P. alessiae* (Fig. 5. C, D).

Distribution

Western and central Mediterranean: with doubt from Early Pliocene of Estepona, Velerín Conglomerates, Spain, and surely from upper Zanclean to Piacenzian (biozones MPL4a-MPL4b) of Stroncoli (Siena), Tuscany, Italy.

Habitat

We suppose rocky shores, intertidally to a few meters in depth, as for *P. ferruginea* and *P. caerulea*.

Conclusions

The reports of fossil Patellidae are generally few, for example in Sacco (1897) there are no references to Pliocene

	Shapiro-Wilk test	Levene's test	ANOVA F	Welch's	p
L	0.124	0.009		32.383	<0.001
La	0.931	0.132	3.358		0.040
H	0.136	0.242	4.889		0.010
D	0.121	0.121	1.304		0.277
Lp	0.082	0.140	2.127		0.126
La/L	0.896	0.004		1.915	0.161
H/L	0.080	0.110	56.925		<0.001

Table 5. Results of statistical analyses carried out on morphometric data from recent *P. depressa* and from recent and fossil *P. caerulea* specimens (in bold, significant p values smaller than 0.05).

erates (Spain) (Landau et al., 2003), Senese Basin, Tuscany, Italy (Chirli, 2004). Recently reported with doubt from Pliocene of Borgomanero (Pasini et al., 2018). Pleistocene: Mediterranean Sea (Malatesta, 1960; Ruggeri & Greco, 1965; Ruggeri & Buccheri, 1968; Cuerda Barceló, 1987; Di Geronimo, 2012. Present-day: Mediterranean Sea.

Habitat

Rocky shores intertidally to a few meters depth (Poppe & Goto, 1991).

Patella alessiae Forli,
Dell'Angelo, Montagna & Taviani, 2004
(Fig. 5. A-M)

2004 *Patella alessiae* Forli et al., p. 6, figs 3a-d, 4a-c.
2018 *Patella alessia* (sic) Forli - Martín-González et al., p. 197.

Material

All the specimens are from "Stroncoli" (Siena) in pebbly sandy sediments. Holotype (MZB 40656a), L 67 mm, D 53 mm, H 18 mm; Paratype MZB 40656b, L 55 mm, D 44 mm, H 15 mm (Fig. 5. A, B) (temporarily retained in MFC).
Adult shell, L 75 mm, D 60,4 mm, H 36 mm (Fig. 5. G, H) (temporarily retained in CMC); adult shell, L 92 mm, D 75 mm, H 28 mm (Fig. 5. L, M) (temporarily retained in F. Ciappelli collection); juvenile shell, L 15 mm, D 11.8 mm, H 2.5 mm (Fig. 5. C, D) (temporarily retained in CMC); juvenile shell, L 24 mm, D 20 mm, H 2 mm (Fig. 5. E, F) (temporarily retained in MFC); large fragment of an adult shell, L 59 mm, D 42.2 mm, H 15 mm (Fig. 5. K) (temporarily retained in CMC); 1 marginal fragment of an adult shell (MZB 40657: temporarily retained in MFC); 3 juvenile incomplete shells and 2 marginal fragments (temporarily retained in CMC).

Description

Shell cap-shaped, oval, depressed, robust, moderately large for the genus (up to 92 mm in length); apex fragile, eroded, slightly directed anteriorly. Sculpture coarse, heavy, constituted by 9 strong, nodose primary radial ribs, initially elevated, almost straight, then irregularly flexuose and trifold, flattening at the shell's margin; primary costae alternate with 9 secondary ribs arranged as the primary one; irregular and more or less distinct interstitial threads are present between primary and secondary ribs. The ribs project at the margin and the resulting outline is noticeably corrugated. Concentric growth increments barely visible. Interior of shell marked by a large spatula with an evident callus (Forli et al., 2004).

Remarks

The pebbly sandy lenses in the outcrop of "Stroncoli" are the source for the specimens of *P. alessiae*. They are found with some Haliotidae species, as reported in Forli et al. (2003), which also contains a preliminary list of the accompanying fauna (*Patella alessiae* was there recorded as *Patella* sp.). The most similar species is *Patella ferruginea* Gmelin, 1791. The palaeontological documentation of *P. ferruginea* in the Mediterranean basin dates back at least to the Pleistocene and the taxon is a recurrent component of the last-interglacial (MIS5e) deposits. Some morphotypes of *P. ferruginea*, occasionally display a remarkably coarse-ribbed ornamentation; however, such ribs are triangular in section, arranged in a regular radiate pattern, resulting also in a different marginal profile, and always more numerous than in *Patella alessiae* (Forli et al. 2004 and references therein). The specimen identified as *P. ferruginea* from the Pliocene of Estepona by Landau et al. (2003, pl. 4, fig. 8) is problematic. It was considered conspecific with *P. alessiae* by Forli et al. (2004), however, images of further specimens from Estepona show some specimens with a rib count similar to that seen in *P. alessiae*, whilst others have more nu-

Specimen code	L	La	LP	H	D
1-V002B	32.6	13.8	18.8	7.6	26.6
2-V002B	31	12.1	18.9	9	25
1-V002G	36.4	14.1	22.3	9.4	31
2-V002G	35.4	14.9	20.5	10.5	30.5
1CB	36	15	21	14	29
2CB	39	17	22	16	29
3CB	32.5	13	19.5	12	25
4CB	25	10	15	11	20
5CB	28	9.5	18.5	10	22
6CB	26	10	16	12	21
7CB	36	14	22	14	27
8CB	31	11	20	10	25
1FS	46	20	26	16	39
2FS	42	17	25	16	37
3FS	33	15	18	12	27
1AP	38.5	13	25	14.6	29
2AP	33.8	13.5	20.3	13.5	29
3AP	38.7	17.3	21.4	15.2	31.4
4AP	23.6	11.6	12	10.7	20
5AP	26	11.85	14.15	10.7	20.5

Table 3. Morphometric data of *Patella depressa* samples.

Therefore, we prefer to maintain the specific name *P. caerulea* for the Pliocene specimens from “Terre Rosse” area (Fig. 3). Recently Martín-González & Vera-Peláez (Martín-González et al., 2018) described *Patella maxoratensis* from the upper Miocene (Tortonian) of Fuerteventura, (Canary Islands) that looks like the Tuscan Pliocene *P.*

caerulea but have the apex situated at the geometric centre of the shell.

Distribution

Middle Miocene: reported dubiously in the Loire Basin by Glibert (1949). Pliocene: Estepona, Velerín Conglom-

		L	La	Lp	H	D	La/L	H/L
<i>P. caerulea</i>								
Recent		30.54 ab	12.02 ab	18.53 a	6.84 b	25.93 a	0.39 a	0.23 c
Fossil	mean	27.15 b	10.44 b	16.21 a	7.79 b	23.75 a	0.38 a	0.29 b
<i>P. depressa</i>								
		33.52 a	13.70 a	19.82 a	12.21 a	27.20 a	0.41 a	0.37 a
<i>P. caerulea</i>								
Recent	SD	8.62	3.43	5.37	2.01	7.64	0.03	0.04
Fossil		9.26	3.97	6.34	4.36	8.28	0.50	0.05
<i>P. depressa</i>								
		5.90	2.74	3.62	2.55	2.93	0.04	0.06
<i>P. caerulea</i>								
Recent	min	17.30	6.70	9.80	2.40	13.30	0.35	0.14
	max	55.00	20.60	35.00	11.30	46.30	0.45	0.30
Fossil	min	9.30	3.00	3.00	2.20	8.00	0.26	0.21
	max	40.40	18.30	24.70	14.00	37.00	0.30	0.38
<i>P. depressa</i>	min	23.60	9.50	12.00	7.60	20.00	0.41	0.33
	max	46.00	20.00	26.00	16.00	39.00	0.44	0.35

Table 4. Means, standard deviation of the mean (SD), minimum and maximum values of morphometric data recorded on recent *P. depressa* and recent and fossil *P. caerulea* specimens. In columns, means followed by the same letters are not statistically different (p>0.05).

e.g. var. *stellata* and *subplana*, sharp peristome as well as a generally less evident impression of the mantle edge. The position of the apex also appears more central. To verify the importance of these differences, a comparison was made measuring 36 and 25 recent and fossil specimens, respectively, of *P. caerulea* originating from: 6 Bosa (Oristano, record number V112C); 3 Calvi (Corsica, V080G), 6 Castiglioncello (Livorno, V016E); 1 La Spezia (V047B); 12 Livorno (V016K), 8 Stavros (Creta, V121A); 5 from Campino (F036A) and 20 from Stroncoli (F036B), according to the parameters shown in the following tables (Tabs 1-2). We also hypothesized a possible correlation with *Patella depressa* Pennant, 1777 (ex *P. intermedia* Murray in Knapp, 1857) measuring 20 recent specimens: 2 each from Getares and Malaga (Spain, V002B, V002G), 4 from La Coruna (Spain, 1-4CB), 2 from Les Palus, Plo-hua (France, 5-6CB), 1 from Dakar (Senegal, 7CB), 1 from Porto de La Linea (Gibilterra, 8 CB), 3 from Tarifa (Spain, 1-3FS) and 5 from La Herradura (Spain, 1-5AP) (Tab. 3). The morphological appearance may lead to hypothesize differences of some importance between the fossil and recent specimens here referred to *P. caerulea*. The morphometric analysis showed differences in the apical position and height (Tabs 1-3).

When the assumptions of ANOVA were fulfilled ($p>0.05$ after Shapiro-Wilk normality test and/or kurtosis <1 and $p>0.05$ after Robust Levene's Test of Homogeneity of Variances), data were submitted to one-way ANOVA ($\alpha=0.05$) and Tukey's HSD, while the Welch's test for unequal variances and Tamhane's T2 test were used to analyse those variables showing normal distribution and non-homogeneous variances (Tabs 4-5). Results showed that the H/L parameter significantly differed between recent and fossil *P. caerulea*, and between species, with the largest values for *P. depressa* and the lowest for recent *P. caerulea* (Tab. 5). The variables L and La were significantly higher in *P. depressa* than in Pliocene *P. caerulea*, while values of the shell height (H) recorded in *P. depressa* were significantly higher than those found in both living and fossil *P. caerulea* shells (Tab. 5). No significant differences were detected among the three groups for the variables D and Lp and the ratio La/L (Tabs 4-5). The detected differences in ornamentation and morphology are limited and do not justify species separation, also in consideration of the variation that may have occurred during the last 3 Ma and potential bias due to the depositional conditions and taphonomic processes.

Specimen code	L	La	LP	H	D
1-F036A	35.4	12.8	22.6	8	31
2-F036A	24	8.1	15.9	5.1	21.2
3-F036A	22	8.2	13.8	6.9	18.5
4-F036B	22.2	9.8	12.4	7	23.5
5-F036B	37.4	15.3	22.1	10.5	33
6-F036B	31	12.3	18.7	9.8	27
7-F036B	28	10.3	17.7	7.6	23.8
8-F036B	27.4	9.9	17.5	8.4	22.6
9-F036B	30.2	12.7	17.5	9.5	26.2
10-F036B	35	14.3	20.7	12	29.6
11-F036B	34.3	12.3	22	13	31
12-F036B	14.4	6.3	8.1	4	11.5
13-F036B	13.5	5.7	7.8	2.8	12
14-F036B	9.4	3	6.4	2.4	8
15-F036B	9.3	3.3	6	2.2	8.2
16-F036B	14.8	6.5	8.3	3.5	11.6
17-F036B	36.3	14.3	22	11.4	30
18-F036B	36.4	18.3	18.1	14	31
19-F036B	23	7.7	15.3	6.2	21.5
20-F036B	40.4	17.4	23	11.3	37
21-F036B	31	9.3	21.7	ND	30.2
22-F036A	38	13.3	24.7	ND	33.5
23-F036B	27.3	10.8	16.5	ND	25
24-F036A	34	11.2	22.8	ND	27.5
25-F036B	24	8	16	8	19.3

Table 2. Morphometric data of fossil *Patella caerulea* samples.

Remarks

There are some morphological differences between the

fossil shells of *P. caerulea* and the extant ones: living shells have a more variable outline and ornamentation,

Specimen code	L	La	LP	H	D
1-V047B	28.3	11.3	17	8.5	24.3
1-V121A	30	11.7	18.3	7.2	26.4
2-V121A	27.4	10.9	16.5	4.8	23.5
3-V121A	22	8.6	13.4	5	19
4-V121A	24.2	10.3	13.9	4.8	20.8
5-V121A	19.3	8.2	11.1	4.6	17
6-V121A	25.2	9.9	15.3	5	20.5
7-V121A	23	9.3	13.7	6.2	18.2
8-V121A	17.4	6.7	10.7	4	13.3
1-V016K	55	20	35	11	46.3
2-V016K	51	20.6	30.4	9	46.2
3-V016K	38	14	24	7	33.3
4-V016K	36.2	13.3	22.9	7.2	32
5-V016K	36.2	13.9	22.3	7	29.2
6-V016K	35.3	15.5	19.8	9.3	30.5
7-V016K	31.8	11.7	20.1	7.4	28.3
8-V016K	28.2	10.9	17.3	6	23
9-V016K	29.5	11.3	18.2	7.1	24.6
10-V016K	38.8	15.7	23.1	11.3	32.3
11-V016K	27.3	10.3	17	7.5	24
12-V016K	19.5	6.8	12.7	5.3	17.2
1-V112C	30	10.7	19.3	5.4	23.6
2-V112C	39	16.3	22.7	6.8	32
3-V112C	35.4	13.6	21.8	8.3	29.4
4-V112C	37	13.7	23.3	7	32.2
5-V112C	36	16.3	19.7	8	31.1
6-V112C	17.3	7.5	9.8	2.4	15.3
1-V016E	34	12.3	21.7	9.1	29
2-V016E	35.5	13.2	22.3	9.2	29.3
3-V016E	32.9	12.3	20.6	8.4	29.3
4-V016E	31	13	18	7	25
5-V016E	30.4	13	17.4	7.4	25.2
6-V016E	36	16.2	19.8	8.5	31.3
1-V080G	21	8	13	4.2	17.3
2-V080G	19.3	7.5	11.8	5	15.4
3-V080G	21.2	8.2	13	4.3	18

Table 1. Morphometric data of recent *Patella caerulea* samples.

aemiliana Zone) when overall uplift of southern Tuscany caused major marine regression and subaerial exposure of the basin. Pliocene deposits are prevalently indicative of marine environments and are represented by nearshore sands and conglomerates which pass basinward to offshore muds (Manganelli et al., 2010, with references) (Martini et al., 2011).

Material and methods

The *Patella* specimens were collected through surface researches, from outcrop exposures in localities Campino and Stroncoli, and partly from washing and sieving of sediment blocks taken from the points where there were greater concentrations of shells in the sediments chosen in the best local environmental conditions in the “Terre Rosse” area. The conservation quality of individual fossil varies greatly according to the granulometry of the sediments in which they are preserved. Specimens of medium-small size are found in the sands while larger fragments or specimens of *Patella alessiae* are generally present in gravelly horizons. This selection is certainly to be attributed to syn- and post-depositional taphonomic processes.

Abbreviations and acronyms: variables recorded, in millimeters, L: anterior-posterior diameter; H: maximum height of the shell, measured from the top of the umbo to the opposite ventral margin; La: length from apex to anterior end; Lp: length from apex to posterior end; D: width (Fig. 2); ND: not detected. Data obtained

were checked for fulfilment of ANOVA assumptions (by Shapiro-Wilk normality test and Robust Levene’s Test of Homogeneity of Variances) and one-way ANOVA, followed by Tukey’s HSD, or Welch’s test for unequal variances, followed by Tamhane’s T2 post-hoc test, were carried out, in order to assess the significance of differences among groups of morphometric parameters values. Statistical analyses were carried out by using the IBM SPSS version 23 software (IBM Corp., Armon, NY Inc., USA). The test, in this specific case, was used as a tool to objectively evaluate the morphometric differences observed between current and fossil specimens, the latter available in evidently limited numbers. CMC, MFC: respectively Massimo Cresti and Maurizio Forlì collection. MZB: Zoological Museum of the University of Bologna; sp/sps: specimen/s; es. esemplare.

Systematics

Class Gastropoda Cuvier, 1795
Subclass Patellogastropoda Lindberg, 1986
Superfamily Patelloidea Rafinesque, 1815
Family Patellidae Rafinesque, 1815
Genus *Patella* Linnaeus, 1758

Patella caerulea Linnaeus, 1758
(Figs 3. B, 4. A-R)

Type species *Patella vulgata* Linnaeus, 1758. Present-day, Europe.

1758 *Patella caerulea* Linnaeus, p. 782.

2003 *Patella (Patella) caerulea* Linnaeus - Landau et al, p. 5, pl. 4, figs 6-7 (cum syn.).

2004 *Patella caerulea* Linné - Chirli, p. 21, pl. 7, figs 12-15.

2018 *Patella caerulea* Linnaeus - Pasini et al., figs 1-3.

Material

Well preserved sps: 20 from “Stroncoli” (F036B), 5 from “Il Campino” (F036A). For dimensions see Table 2. Poorly preserved sps: 10 from “Stroncoli”, 11 from “Il Campino”, (Pliocene, upper Zanclean/Piacenzian).

Description

Shell of medium size, patellar, oval, thin, slightly conical, longer than wide with apex in the first anterior third of the antero-posterior diameter. Sculpture: seven - nine primary radial ribs with several secondary and tertiary less prominent ribs crossed by concentric growth lines, giving the shell an imbricate appearance. Peristoma not sharp, slightly ridged margin. In ventral view the impression of the mantle edge shows a dark broad band at half of the height of the shell, open anteriorly. Shell color, preserved in some little-medium specimens, consists in concentric black/brown flammulae irregularly arranged.

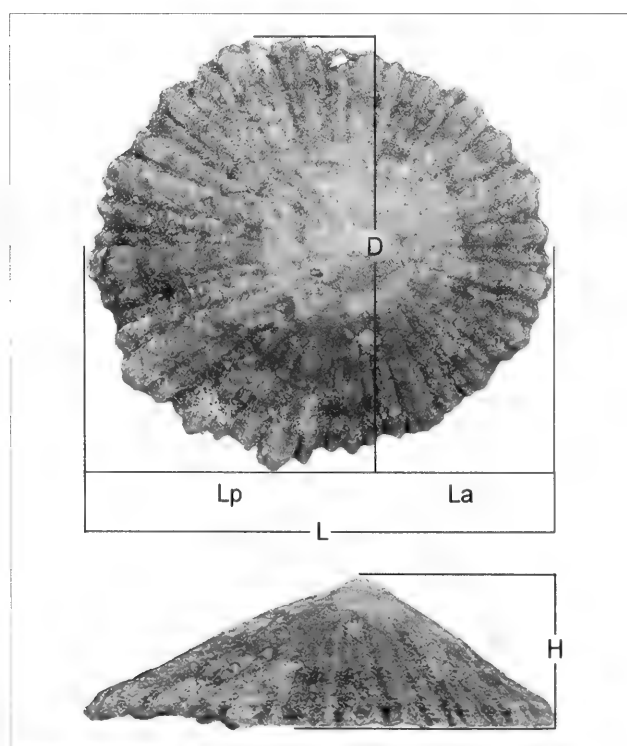


Fig. 2. Variables recorded: antero-posterior diameter (L), length from apex to anterior end (La), length from apex to posterior end (Lp), shell height (H) and width (D).

tions since their position relative to the shore influences their exposure to desiccation, hydrodynamic action of the waves, temperature variation, and tidal width. This impressive phenotypic plasticity allied to the relatively simple shell geometry, convergent shell shape, and sculpturing results in an unclear *Patellid limpet's taxonomy*" (Henriques et al., 2017). Nonetheless, in fossil species, morphological characters are the most important available features for species-level identification. Until there were relatively few records of extinct European Neogene patellids (see references in Forli et al., 2004, p. 4) recently implemented by Wesselingh & Pouwer (2011), Ceulemans et al. (2016), Martín-González et al. (2018), Pasini et al., (2018).

Geological setting

The fossil patellids have been found in the Terre Rosse area in the Siena province (Tuscany, central Italy) that provided and still provides a wealth of palaeontological documentation for the Pliocene epoch of the Mediterranean basin. The outcrops from which the species come, are yellow sands in the locality "Il Campino" and yellow sands rich in pebbly-sandy lenses in the locality "Stroncoli", both close one to each other and not far from Castelnuovo Berardenga. This restricted area has

proved to be of exceptional value in supplying fossil mollusc shells from littoral environments, including representatives of the intertidal zone, only rarely preserved as fossils. These same localities are reported, for example, in Laghi (1984), Spadini (1986, 1990, 2006), Dell'Angelo & Forli (1995), Andreoli & Marsigli (1997), Forli et al. (2003), Chirli (2004), Forli et al. (2004). The sedimentary succession dated from upper Zanclean to Piacenzian (biozones MPL4a-MPL4b) consists of prevalent sands irregularly alternating with more or less extensive and massive gravel lenses (Fig. 1). The presence among the gastropods, of numerous representatives of the families Trochidae (Spadini, 1986, Andreoli & Marsigli, 1997), Strombidae (*Tethystrombus coronatus* DeFrance, 1827), Conidae (Spadini, 1999) and Terebridae (*Strioterebrum pliogenicum* Fontannes, 1881), accompanied by bivalves that did not overcome the first climatic crisis that occurred in the Piacenzian, for example *Codakia leonina* (Basterot, 1825), *Arcopagia sedgwicki* (Michelotti, 1839), *Gari labordei* (Basterot, 1825), *Pelecypora gigas* (Lamarck, 1818), indicates for the malacological association, an age preceding the climatic deterioration of 3 Ma, therefore in the MPMU1 interval (Monegatti & Raffi, 2001). Generally, in the Siena Basin, Pliocene sedimentation start in the Early Pliocene (*Sphaeroidinellopsis seminulina* l.s. Zone) until the Piacenzian (*Globorotalia crassaformis* /

Further records of the Family Patellidae Rafinesque, 1815 (Mollusca: Gastropoda) in the Tuscan Pliocene

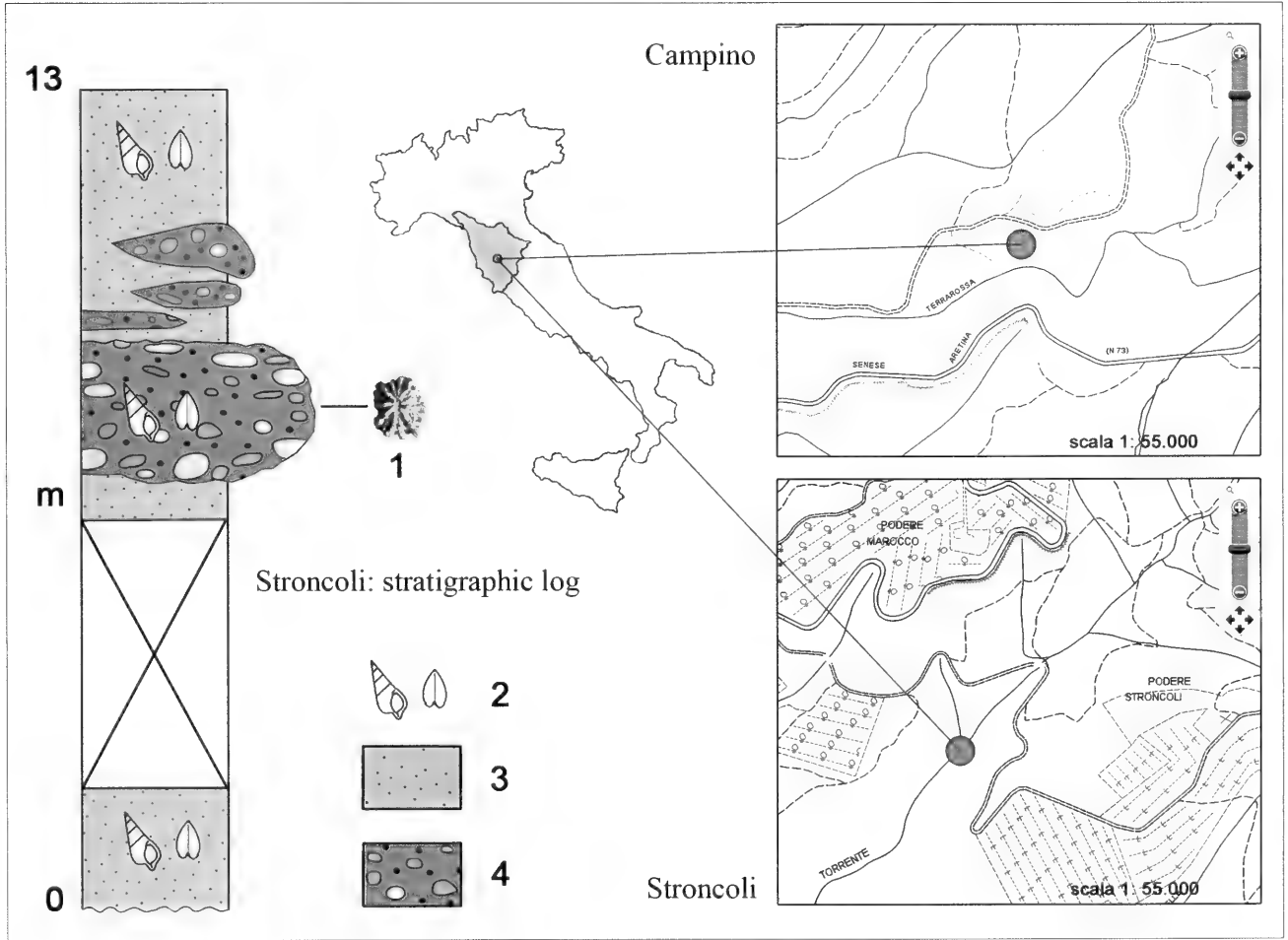


Fig. 1. Geological setting of the most important fossiliferous outcrop in the Terre Rosse Area, between Podere Marocco and Podere Stroncoli (43°19'59,4"N, 11°35'42,8"E), known how "Stroncoli" and geographic position of "Il Campino" (43°20'17,6"N, 11°34'46,3"E): (1) *Patella alessiae* Forli et al., 2004; (2) Molluscs; (3) Sands; (4) Pebbly sandy lenses (Forli et al., 2004, modified). Topographic map from <https://castelnuovobga.ldpgis.it>

Further records of the Family Patellidae Rafinesque, 1815 (Mollusca: Gastropoda) in the Tuscan Pliocene

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Abstract

The reports of fossil Patellidae are generally few, for example in Sacco (1897) there are no references to Pliocene specimens. Despite the countless studies on the Tuscan Pliocene malacofauna from the nineteenth century to date, only two reports were published before this note for specimens from the same localities reported here and Tuscany in general. We here report on specimens from "Terre Rosse" (Pliocene, upper Zanclean - Piacenzian), an area near Siena, in central southern Tuscany. The reported species are *Patella caerulea* Linnaeus, 1758, and *Patella alessiae* Forlì et al., 2004. We used ANOVA to test for differences between our material tentatively identified as *P. caerulea* and recent specimens of *P. caerulea* and *P. depressa*.

Notwithstanding the limited sample size, which may reduce the power of the test, some parameters consistently showed significant differences in particular related to the position of the apex, a little more shifted towards the geometric center, and height, significantly greater in the fossil specimens. The H / L ratio has also values in the fossil specimens being between the maximum of *P. depressa* and the minimum of current *P. caerulea*. Nonetheless, these and other differences in ornamentation were not deemed sufficient for a specific separation of our material from *P. caerulea*. *Patella alessiae* has been compared to *P. ferruginea* Gmelin, 1791, confirming the differences found at the time of its first description.

Key Words

Patellidae, Pliocene, Tuscany.

Riassunto

In questo articolo continuiamo le nostre brevi segnalazioni sulla malacofauna fossile toscana occupandoci della Famiglia Patellidae Rafinesque, 1815. In particolare gli esemplari esaminati provengono dalla Toscana centro meridionale, nel senese, nella zona conosciuta in letteratura come Terre Rosse. I fossili sono stati recuperati, tramite raccolte di superficie effettuate in più anni, nei sedimenti sabbiosi alternati irregolarmente da lenti più o meno estese e potenti di ghiaie, sparsi in tutta la zona presa in esame. La loro età è attribuibile all'intervallo Zancleano superiore - Piacenziano (Pliocene). Sono discusse e illustrate *Patella caerulea* Linnaeus, 1758 e *Patella alessiae* Forlì et al., 2004, al momento, le sole note nel pliocene toscano. In base alla forma e all'ornamentazione, ipotizzando una qualche affinità morfologica degli esemplari fossili di *P. caerulea* con quelli attuali della stessa specie e con *Patella depressa* Pennant, 1777, più individui delle tre specie sono stati misurati e confrontati su base statistica tramite il test ANOVA che, nel caso specifico è utilizzato come strumento per poter valutare oggettivamente le differenze morfometriche osservate tra esemplari attuali e fossili, questi ultimi disponibili in numero evidentemente limitato. Nonostante le incertezze dovute allo scarso materiale fossile disponibile e ad altri eventuali variabili intervenute, ad esempio le caratteristiche sedimentarie degli affioramenti dai quali provengono, necessariamente, i campioni e la modalità di raccolta, il test ha evidenziato che nonostante l'elevata variabilità morfologica, alcuni parametri sono risultati significativamente diversi. Il confronto morfometrico tra gli esemplari fossili e quelli attuali di *P. caerulea* ha evidenziato alcune differenze, in particolare la posizione dell'apice un poco più spostato verso il centro geometrico e complessivamente un'altezza significativamente maggiore negli esemplari fossili. A livello statistico però, si sono ottenute differenze significative solo per il rapporto H/L, con il valore negli esemplari fossili che si pone tra quello massimo di *P. depressa* e quello minimo di *P. caerulea* attuale. Ciò nonostante, queste ed altre variazioni nell'ornamentazione, non sono state ritenute sufficienti per una separazione specifica. *Patella alessiae*, come nella descrizione originale, è stata paragonata a *P. ferruginea* Gmelin, 1791, confermando le differenze riscontrate al momento della sua istituzione.

Parole chiave

Patellidae, Pliocene, Toscana.

Introduction

The aim of this work is to present the species of the family Patellidae Rafinesque, 1815 (Patellogastropoda) found in a restricted area of the Pliocene basin around Siena (Tuscany) known in the literature as "Terre Rosse", near Rapolano.

The representatives of this family are worldwide distributed. Most members of the family inhabit rocky substrata of high-energy shores with vertical distribution generally ranging from the upper to the lower shore levels (Powell, 1973). A few exceptions are known, none of which belong to *Patella* s.s.

"Limpets can exhibit varying degrees of structural adapta-

(Empoli, Italy), Alessandro Raveggi (Firenze, Italy), Carlo Sbrana (Livorno, Italy), Maria Scaperrotta (Firenze, Italy), Rino Stanić (Split, Croatia), Daniele Trono (Copertino, Italy), Michele Zilioli (MNHM). We are grateful to all of them.

References

ALBANO P.G., SABELLI B. & BOUCHET P., 2011. The challenge of small and rare species in marine biodiversity surveys: micro-gastropod diversity in a complex tropical coastal environment. *Biodiversity and Conservation*, **20**: 3223–3237. <https://doi.org/10.1007/s10531-011-0117-x>

ALBANO P.G., STEGER J., BAKKER P.A.J., BOGI C., BOŠNJAK M., GUY-HAIM T., HUSEYINOGLU M.F., LAFOLLETTE P.I., LUBINEVSKY H., MULAS M., STOCKINGER M., AZZARONE M. & SABELLI B., 2021. Numerous new records of tropical non-indigenous species in the Eastern Mediterranean highlight the challenges of their recognition and identification. *ZooKeys*, **1010**: 1–95. <https://doi.org/10.3897/zookeys.1010.58759>

ALBANO P.G., BAKKER P.A.J., SABELLI B., 2019. Annotated catalogue of the types of Triphoridae (Mollusca, Gastropoda) in the Natural History Museum of the United Kingdom, London. *Zoosystematics and Evolution*, **95** (1): 161–308. <https://doi.org/10.3897/zse.95.32803>

BOUCHET P., 1985. Les Triphoridae de Méditerranée et du proche Atlantique (Mollusca, Gastropoda). *Lavori della Società Italiana di Malacologia*, **21**: 5–58.

BOUCHET P., 1997. Nouvelles observations sur la systématique des Triphoridae de Méditerranée et du proche Atlantique. *Bollettino Malacologico*, **31** (9-12): 205–220.

BOUCHET P. & STRONG E., 2010. Historical name-bearing types in marine molluscs: an impediment to biodiversity studies? In Polaszek A. (ed.), *The Linnaean Ark - Systema Naturae 250*. CRC Press, London: 63–74.

COSSIGNANI T. & ARDOVINI R., 2011. *Malacologia Mediterranea. Atlante delle conchiglie del Mediterraneo: 7500 foto a colori*. Ancona, L'Informatore Piceno. 540 pp.

DELONGUEVILLE C. & SCAILLET R., 2016. Présence de *Monophorus amicitiae* Romani, 2015 (Gastropoda: Triphoridae) aux îles Egades, nord-ouest de la Sicile, Italie. *Novapex*, **17** (1): 27–28.

DELONGUEVILLE C. & SCAILLET R., 2021. Note on *Monophorus amicitiae* Romani, 2015 (Gastropoda, Triphoridae), extension

of its distribution to the Central Mediterranean Sea. *Novapex*, **22** (1-2): 51–52.

GOFAS S., MORENO D. & SALAS C., 2011. *Moluscos marinos de Andalucía: I. Introducción general, clase Solenogastres, clase Caudofoveata, clase Polyplacophora y clase Gastropoda (Prosobranchia)*. Servicio de Publicaciones e Intercambio Científico, Universidad de Málaga: Málaga. XVI, 342 pp.

ICZN [INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE], 1999. International code of zoological nomenclature, Fourth ed. London: International Trust for Zoological Nomenclature. Accessed at <http://www.iczn.org/> on 2021-02-22

MOLLUSCABASE EDS, 2021. MolluscaBase. Accessed at <http://www.molluscabase.org> on 2021-02-22 doi:10.14284/448

MOLLUSCABASE EDS., 2021a. MolluscaBase. Triphoridae Gray, 1847. Accessed through: World Register of Marine Species at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=131> on 2021-02-22

MANOUSIS T., KONTADAKIS C., POLYZOULIS G., MBAZIOS G. & GALINOUMITSOU S., 2018. New marine gastropod records for the Hellenic waters. *Journal of Biological Research-Thessaloniki*, **25** (1): 1–33.

MARSHALL B.A., 1983. A revision of the Recent Triphoridae of southern Australia. *Records of the Australian Museum, supplement*, **2**: 1–119. 10.3853/j.0812-7387.2.1983.102

PEÑAS A., ROLÁN E., LUQUE A.A., TEMPLADO J., MORENO D., RUBIO F., SALAS C., SIERRA A. & GOFAS S., 2006. Moluscos marinos de la isla de Alborán. *Iberus*, **24** (1): 23–151. <http://doi.org/10.5281/zenodo.4527554>

ROLÁN E. & PEÑAS A., 2001. Two new species of the genus *Monophorus* (Gastropoda, Triphoridae) in the east Atlantic and Mediterranean Sea. *Iberus*, **19** (2): 31–40. <http://doi.org/105281/zenodo.4514872>

ROMANI L., 2015. A new Mediterranean *Monophorus* species (Gastropoda: Triphoridae). *Bollettino Malacologico*, **51** (1): 3–8.

TRONO D., 2016. Prima segnalazione di *Monophorus amicitiae* Romani, 2015 (Gastropoda: Triphoridae) e *Fusinus corallinus* Russo & Germanà, 2014 (Gastropoda: Fasciolaridae) per il Salento. *Thalassia Salentina*, **38**: 143–147.

VERDUIN A., 1977. On a remarkable dimorphism of the apices in many groups of sympatric, closely related marine gastropod species. *Basteria*, **41** (5-6): 91–95.

WELLS F.E., 1998. Superfamily Triphoroidea, in Beesley P.L., Ross G.J.B. & Wells A. (eds), *Mollusca: the Southern Synthesis*, Vol. 5, Part B. CSIRO Publishing, Melbourne, 808–811.

New data on *Monophorus alboranensis* Rolán & Peñas, 2001 (Gastropoda: Triphoridae)

variability. Present data show that *M. alboranensis* is a more variable species as regards most conchological parameters, and in contrast to what resulted from the two original descriptions.

The characterization of *M. amicitiae* was affected by additional issues: all shells of the type series fell within the lower part of the species range with regards to H, NP, W/H, C4-C6 sculptural strength, while in the higher part with regards to DP (e.g. **Fig. 1. B**), giving the wrong impression of a morphological gap between the two taxa, with *M. alboranensis* having larger shells, protoconch more conical and whorled, and stronger sculptured basal cords (**Fig. 1. A**). This, along with the original description and figures of *M. alboranensis*, which also contain some small inaccuracies (H 8.0 mm instead of 7.6 mm, C2 appearance around 7.5 instead of 6), led the first author to wrongly assign some *Monophorus* shells from the Alboran Sea to *M. alboranensis*. These individuals, which were used for direct comparison with *M. amicitiae* type material, belong in fact to different species (**Fig. 3. A-D**) (see below). This case remarks that an adequate number of specimens, as well as direct comparison with type material of related species, are strictly necessary in describing species, above all when relying only on conchological grounds. This is particularly true when studying groups, like the triphorids, that include many similar species which can be separated only by small details, or potentially possess a high level of morphological plasticity. Although the status of *M. alboranensis* and *M. amicitiae* cannot be definitively settled until anatomical and molecular information will be available, present data strongly support the hypothesis that the two taxa belong to the same species, and the synonymy between them is the most suitable act at the moment.

Light-coloured shells, originating from the Alboran Sea and clearly assignable to the genus *Monophorus*, have

been known for years (**Fig. 3. A-D**). This form is frequently mistaken for *M. alboranensis* due to the very similar chromatic pattern, and the overlapping geographical range. However, it can be readily distinguished from *M. alboranensis* by virtue of its larger, conical protoconch, with a smaller nucleus (**Fig. 3. A', D'**). It shares most of the morphological features with *M. erythrosoma* (Bouchet & Guillemot, 1978) and, pending further studies, it's here recorded as *Monophorus* cf. *erythrosoma*. Here we also reported a single *Monophorus* shell, characterized by a small cylindrical protoconch with a relatively large nucleus, resembling that of *M. alboranensis* (**Fig. 3. G'**), but possessing a totally different teleoconch, characterized by an ovoidal-pyriform outline and a brownish colour (**Fig. 3. G**). As it has no clear affinities with the four Mediterranean *Monophorus* species, it is provisionally recorded as *Monophorus* sp. Although the taxonomy of the Mediterranean *Monophorus* species is generally regarded as mostly settled, these examples suggest a more complex picture than is currently recognized.

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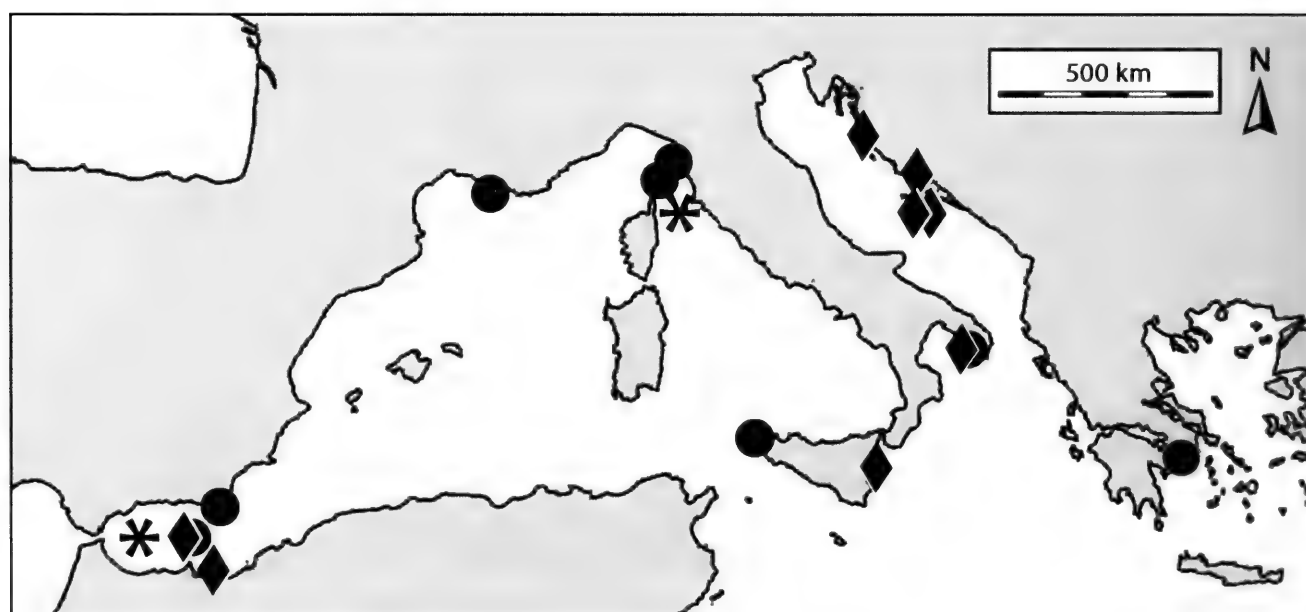


Fig. 4. *Monophorus alboranensis* known records. Asterisks: type localities of *M. alboranensis* (Alboran Sea) and *M. amicitiae* (N Tyrrhenian Sea); black circles: records from literature; diamonds: new records.

from the Alboran to the Aegean Sea, including the Tyrrhenian, Adriatic and Ionian seas. Shells have always been found in small numbers except on the Dalmatian coast. This scattered distribution and low abundance, rather than denoting a real rarity of the species, are probably a consequence of a scarcely sampled habitat and the difficulty to distinguish it from other similar triphorids.

Discussion

Although the integrative approach can be considered as the optimal method in alpha-taxonomy, the morphology

of shells remains widely used for the delimitation and description of molluscs. The limits of such a method are evident, as it is well known that shells are characterized by a wide morphological variability, preventing a correct evaluation of phenotypic plasticity or the occurrence of cryptic species. Descriptions or characterizations of species based on small samples increase the risk of errors. This seems to have been the case in the current study: both *M. amicitiae* and *M. alboranensis* were described on a few specimens, and as a consequence, a robust assessment of the intraspecific morphological variability of the two taxa was not feasible. The opportunity to examine a large set of *M. alboranensis* shells allowed a better understanding of its morphological

New data on *Monophorus alboranensis* Rolán & Peñas, 2001 (Gastropoda: Triphoridae)

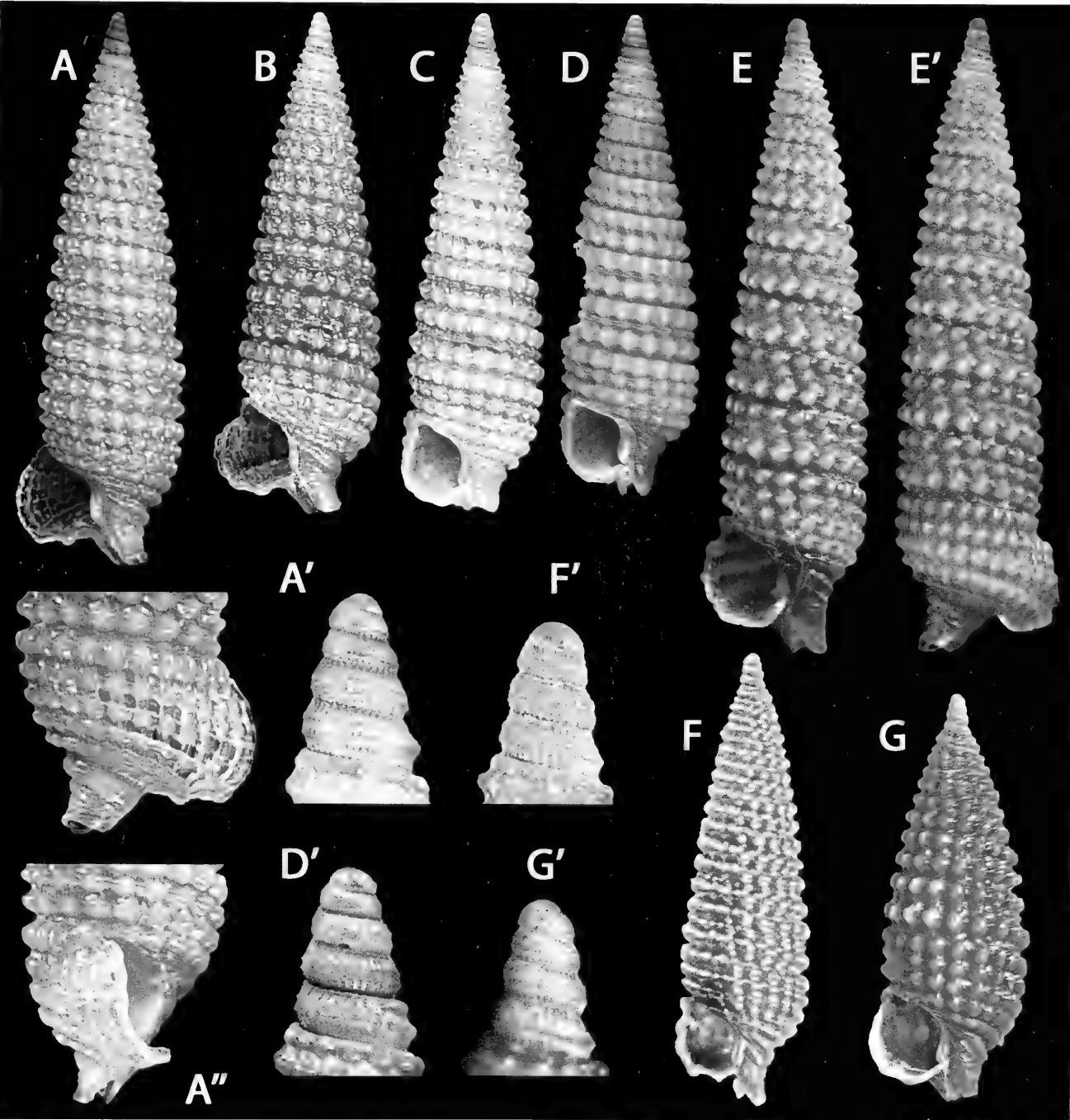


Fig. 3. A-G *Monophorus* spp. A-D. *Monophorus* cf. *erythrosoma*, A. 6.6 mm, Almeria (Spain) (AP); B-C. both 5.8 mm, La Herradura (Spain) (SB); D. 5.7 mm, Secos de los Olivos (Spain) (AP); E. *M. alboranensis*, 7.8 mm, Alboran platform (Spain), photographed by Serge Gofas (University of Malaga); F. *M. alboranensis* paratype, 5.4 mm (MNHN-IM-2000-737), photographed by Philippe Maestrati (MNHN); G. *Monophorus* sp., 4.9 mm, Capraia Island (Italy) (LR).

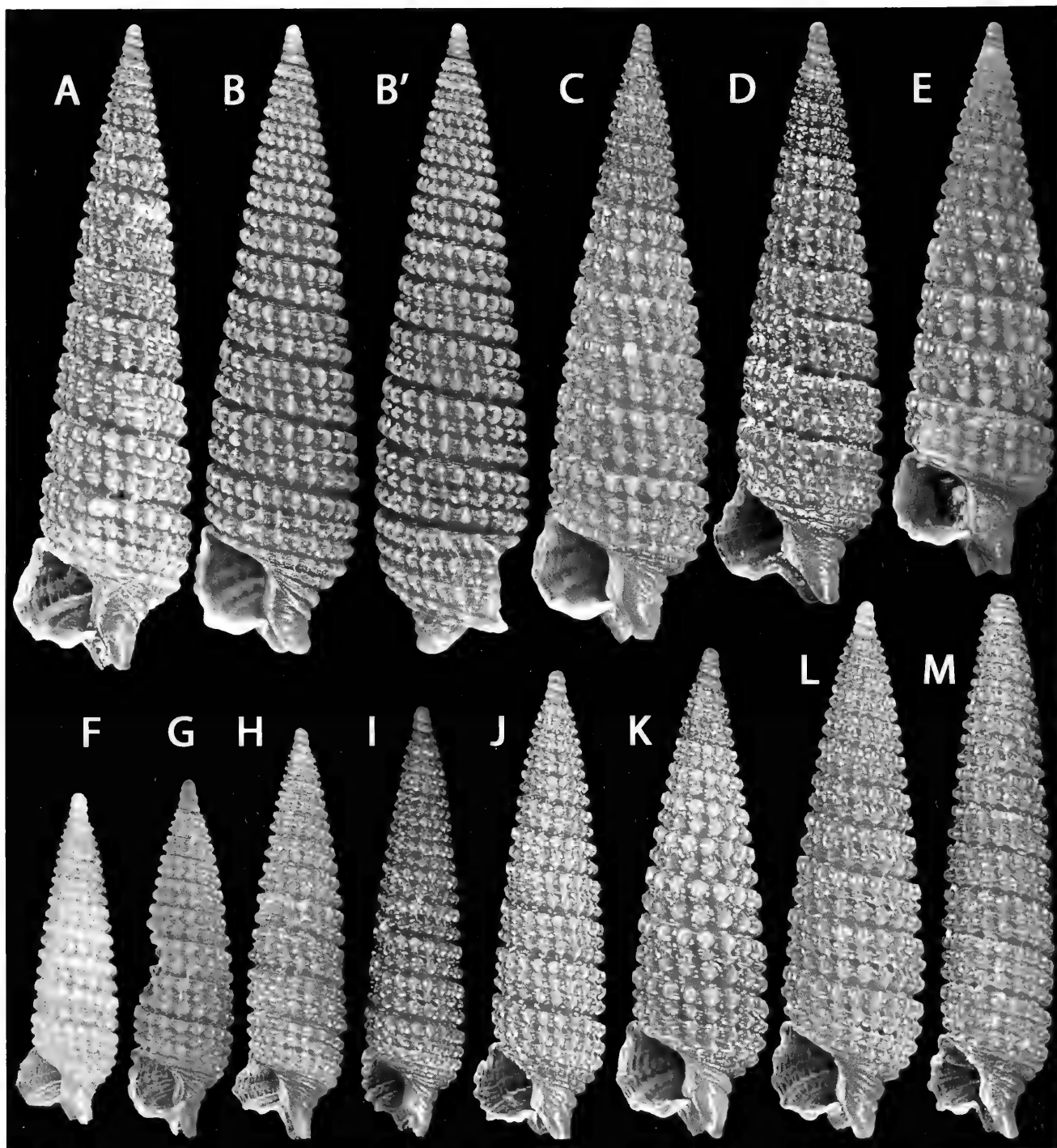


Fig. 2. A-M. *Monophorus alboranensis*. **A.** 8.8 mm, Lastovo Island (Croatia) (JP); **B.** 8.4 mm, Lastovo Island (Croatia) (RS); **C.** 8.3 mm, Mljet Island (Croatia) (JP); **D.** 7.6 mm, Mljet Island (Croatia) (JP); **E.** 7.1 mm, Tuscan Archipelago (Italy) (AP); **F.** 4.5 mm, Porto Cesareo (Italy) (DT); **G.** 4.9 mm, Quercianella (Italy) (CS); **H.** *Monophorus amicitiae* paratype A, 5.3 mm, Fetovaia (Elba island, Italy) (LR); **I.** 5.4 mm, Porto Cesareo (Italy) (GM); **J.** 5.7 mm, Mljet Island (Croatia) (JP); **K.** 6 mm, Mljet Island (Croatia) (JP); **L.** 6.7 mm, Mljet Island (Croatia) (JP); **M.** 6.8 mm, Capraia Island (Italy) (AP) [*M. cf. amicitiae*, in Romani, 2015].

they occur under stones in association sponges (J. Prkić unpublished data). *M. alboranensis* probably feeds on sponges too, but unfortunately, the only live-taken specimen was not found in association with a host, so its life habit can be only speculative. However, the rich samples from Croatia and Chafarinas Islands came from rocky bottoms with red coral colonies (depth 50–100 m), so it can be hypothesized that the preferential host of *M. alboranensis* could be represented by sponges associated to *Corallium rubrum* (Linnaeus, 1758). In Croatia, bottoms with red coral are particularly rich in molluscs, and over 300 species have been recorded in this

habitat (J. Prkić pers. obs.). Aside from *M. alboranensis*, Triphoridae associated to red coral bottoms include: *Cheirodonta pallescens* (Jeffreys, 1867); *Marshallora adversa* (Montagu, 1803); *Monophorus alboranensis* Rolán & Peñas, 2001; *M. erythrosoma* (Bouchet & Guillemot, 1978); *M. perversus* (Linnaeus, 1758); *M. thiriota* Bouchet, 1985; *Obesula marinostri* Bouchet, 1985; *Ionthoglossa pseudocanarica* (Bouchet, 1985); *Similiphora similior* (Bouchet & Guillemot, 1978); *Strobiligera flammulata* Bouchet & Warén, 1993 and *Metaxia metaxae* (Delle Chiaje, 1828).

Based on the current revision, *M. alboranensis* ranges

Systematics

Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Superfamily Triphoroidea Gray, 1847
Family Triphoridae Gray, 1847
Subfamily Triphorinae Gray, 1847
Genus *Monophorus* Grillo, 1877

Type species: *Trochus perversus* Linnaeus, 1758 (by monotypy)

Monophorus alboranensis Rolán & Peñas, 2001

Monophorus amicitiae Romani, 2015: **syn. nov.**
M. alboranensis Rolán & Peñas, 2001: p. 19-20, figs. 5, 6, 10, 13-17 [Alboran Sea, Spain].
M. alboranensis - Peñas et al., 2006: p. 64, 66, figs. 71, 78; Gofas et al., 2011: p. 149 and figure; Cossignani & Ardevini, 2011: p. 163 and figure. All figures are reproductions from Rolán & Peñas, 2001.
M. amicitiae Romani, 2015: p. 4-7, figs. 1A-G, 2C-G [Northern Tyrrhenian Sea, Italy].
M. amicitiae - Delongueville & Scaillet, 2016: p. 27-28, fig. 3A-C [Egadi Islands, Italy]; Trono, 2016: p. 145, fig. 1 [Salento, Italy]; Manousis et al., 2018: p. 21, figs 15a-b [Saronikos Gulf, Greece]; Delongueville & Scaillet, 2021: p. 51-52, fig. 1A-E [Gulf of Lion, France].

Diagnosis

Small to medium-sized *Monophorus*, shell slender, straight-sided, colour whitish to light-brown. Protoconch with a variable number of whorls (2.5-4.1), generally around 3.3. Embryonic whorl very large, giving a cylindrical outline to the protoconch. Teleoconch sculptured by three spiral cords crossed by opisthocline axial ribs. Last whorl with 7 spiral cords, sculptured chords ranging from C1-3 to C1-6.

Updated description (based on type material and mature shells, with fully developed outer lip)

Shell small (Figs. 1, 2), up to 8.8 mm, elongate, conical to subcylindrical (H/W 3.1-4.1) (e.g. Fig. 2. E, M), quite solid, sinistral. Protoconch more or less cylindrical, multispiral (HP 430-580 µm), composed of a variable number of whorls (NP 2.5-4.1), width and outline are also quite variable (Fig. 1. A', B'). Embryonic shell large (DE 200-230 µm), nucleus surface initially marked by an irregular faint microsculpture, later covered by close cruciform tubercles, often regularly arranged to form a reticulated pattern (Fig. 1. C"). Larval shell whorls convex, ornamented by two equidistant spiral cords crossed by numerous thin axial riblets, which are slightly opisthocline, generally complete and regular (Fig. 1. C'). In the distal zone of the larval shell spiral cords attenuate and get closer medially, axial ribs become irregular and thin out (Fig. 1. C'). Protoconch colour varies from whitish to light brownish. Protoconch/teleoconch tran-

sition clearly delimited. Teleoconch composed of flat-sided whorls (NT 9.3-12.5), suture shallow but clear. Teleoconch sculpture consists of spiral cords crossed by axial ribs to forming strong roundish nodules at the intersections (Fig. 1. C). The beginning of the teleoconch characterized by one medial keel continuing with C3, C1 follows immediately after. C2 starts as a subtle medial thread, regularly increasing in size until the penultimate whorl where it is equal to the others. In some shells C2 remains smaller than C1 and C3. C2 appearance highly variable, occurring between 5.5 and 8.5 whorls. On the body whorl nodules decrease in size from C1 to C3. Base quite rounded, with four additional cords: C4 nodulous or slightly crenulated, rarely almost smooth; C5 often sculptured or less commonly smooth; C6 usually smooth, while C7 always smooth. C6-C7 adherent to the siphon. Additional spiral cordlets at the end of the last whorl absent in smaller shells, while larger ones often have two weak additional cords (between C2 and C3, and between C3 and C4) (Fig. 3. E'). Axial ribs more or less opisthocline, evenly crossing whorls, evanescent below C5, in the number of 18-26 on the body whorl. No axial sculpture below C5, except growth lines. Spiral and axial sculpture weaken approaching the outer lip. Aperture subquadrate with a small posterior sinus. Outer lip sharp, opisthocline viewed by side. Columellar callus whitish, more evident near the columellar-siphonal border. Anterior siphonal canal oblique, tubular, rather long, almost closed at its base. Shell surface glossy, only weak growth lines occur, without an appreciable microsculpture. Background colour of the teleoconch white-yellowish to brownish, except the base of body whorl that commonly is darker (Fig. 2). Shells generally monochromatic, sometimes with nodules lighter than interspaces, rarely show a mottled pattern with paler and darker areas (Fig. 1. A). Periostracum extremely thin and transparent. Operculum very thin, almost transparent, ovoidal and paucispiral (about 2.5 whorls), with subcentral nucleus, almost fitting the aperture (see Romani, 2015: fig. 2D). Animal unknown. Radula unknown. Shells of *M. alboranensis* with intact protoconch can be relatively easily identified according to the characters of protoconch, which has the largest embryonic part among all Mediterranean triphorids, a low number of whorls, and more or less cylindrical outline.

Habitat & Distribution

In the literature, *M. alboranensis* was reported from maerl beds (Manousis et al., 2018), rocky fragments (Delongueville & Scaillet, 2016), and coralligenous bottoms (Peñas et al., 2006; Romani, 2015; Trono, 2016). This species lives in relatively deep waters (20-200 m) if compared to the other Mediterranean *Monophorus* (mostly 0-100 m). In addition, it is the only *Monophorus* species that does not live in very shallow water, while all other species (*M. erythrosoma*, *M. perversus* and *M. thiriota*) can also be found in the intertidal zone (0-1 m), where

Monophorus erythrosoma (Bouchet & Guillemot, 1978). CROATIA: 67 shs, Mljet Island (Dubrovnik-Neretva), 70-100 m, red coral bottoms, in JP; 30 shs, Lastovo Island (Dubrovnik-Neretva), 80-90 m, red coral bottoms, in JP; 1 lv, Murter Island (Šibenik-Knin), 4 m, in JP; 3 lv, Prapratno (Dubrovnik-Neretva), 4-6 m, in JP; 4 lv, Ugljan Island (Zadar), 2-3 m, in JP; 3 lv, Dugi Otok Island (Zadar), 32-40 m, in JP. ITALY: 5 shs, Palinuro (Salerno), 30 m, in LR; 12 shs, Milazzo (Messina), 35 m, in LR; 7 shs, Cannizzaro (Catania), 30-35 m, in LR.

Monophorus sp. ITALY: 1 sh, Capraia Island (Livorno), 40 m, in LR (Fig. 3. G).

Results

About 100 shells of a light-coloured *Monophorus* were collected along the Dalmatian coasts over 30 years of research. Some of them have dried soft parts deep inside the shell. The examination of such a large number of shells has allowed to properly assess the variability of the protoconch and teleoconch features. A subset of 16 shells covering the overall morphological variability was selected, and some parameters were measured. Significant variability was ascertained for the protoconch features: the protoconch size varied considerably (HP: 430-570 μ m, mostly 530 μ m), as did the number of protoconch whorls (NP: 2.5-4.1, mostly 3.5), outline and colour (whitish to light brownish). Nonetheless the protoconch is generally cylindrical, with a large embryonic whorl (diameter 200-230 μ m, mostly

215 μ m). The teleoconch varies in size (HT: 5.1-8.7 mm), number of whorls (NT: 9.3-12.5) and outline, from narrow and cylindrical to wide and conical (H/W: 3.1-4.1), while colour ranges from white-yellowish to brownish, monochromatic or with nodules lighter than the background. C2 appears between 6.8 and 8.5 whorls. On the last whorl there are always 7 spiral cords: C1-C4 are nodulous (C4 rarely crenulated), C5 can be sculptured (often) or smooth (quite rarely), C6 is usually smooth, while C7 is always smooth. Additional spiral cordlets at the end of the outer lip are absent in small and medium-sized specimens, while the larger ones often have two weak additional cordlets (between C2 and C3, and between C3 and C4). Characters such as H, HP and C2 appearance do not correlate, as larger specimens do not necessarily have larger protoconch or a C2 appearing at an earlier developmental stage. The majority of shells matched the original description of either *M. alboranensis* or *M. amicitiae*, although intergrading morphs were observed. This observation suggests that the two nominal species fall within the morphological variability of the Croatian *Monophorus* samples, and that there is a continuum corresponding to the variability of a single species. For priority rules, the name to be used for this species is *Monophorus alboranensis* which is the older available name, while *Monophorus amicitiae* is synonymized with the former (ICZN 1999, Art. 24). The examined shells from Italian localities, though on average reaching a smaller size, confirm this synonymy.

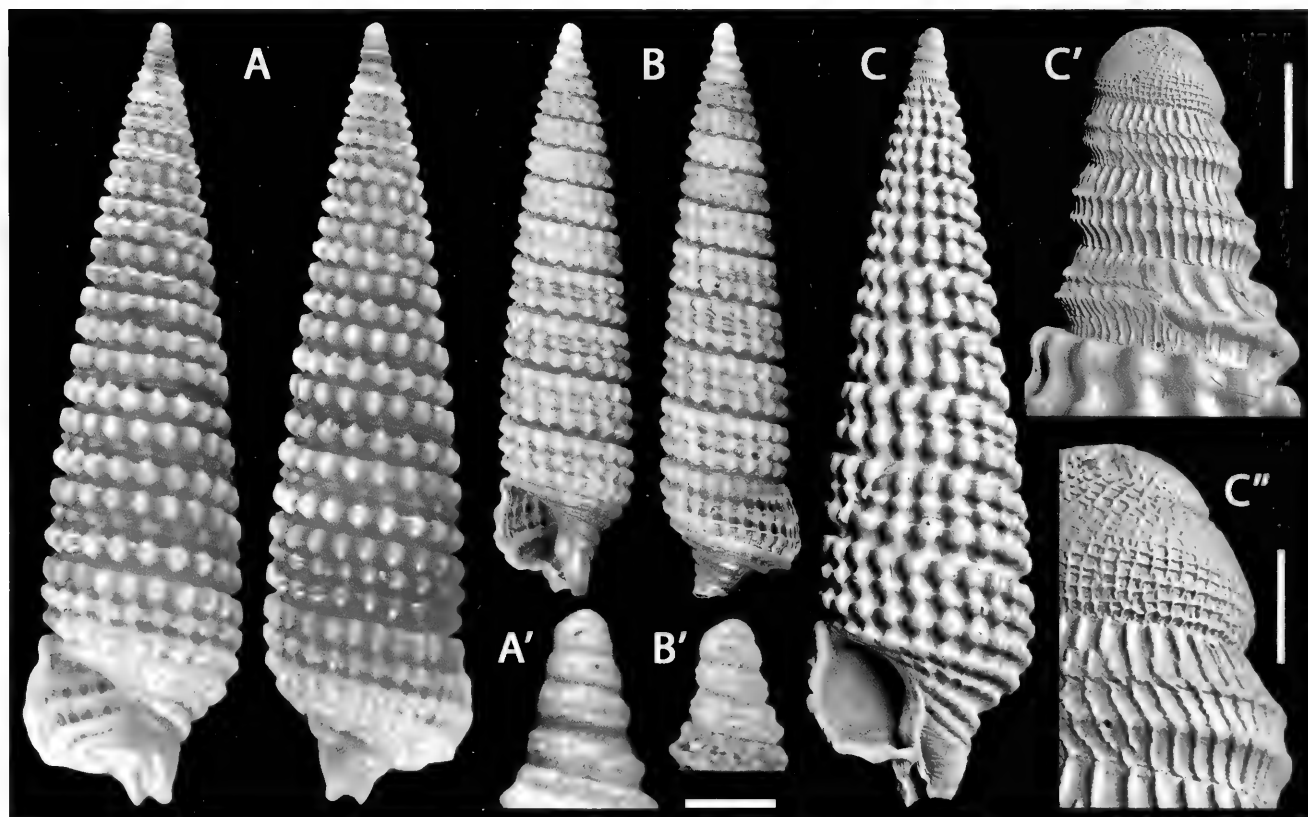


Fig. 1. A-C *Monophorus alboranensis*. **A.** holotype, 8.0 mm, Alboran Sea (MNCN 15.05/44159), photographed by Rafael Araujo (MNCN); **B.** *Monophorus amicitiae* holotype, 5.6 mm, Fetovaia (Elba Island, Italy) (MNHN IM-2000-28031), photographed by Manuel Caballer (MNHN), Projet: RECOL-NAT (ANR-11-INBS-0004); **C.** *M. alboranensis*, 5.9 mm, Mljet Island (Croatia) (JP), photographed by Michele Zilioli (MNHN). Scale bars 300 μ m (A', B), 200 μ m (C'), 100 μ m (C'').

yellow in background with darker areas distributed along the spire), slender shell, protoconch with less than four whorls and large nucleus, and C4 and C5 nodulous (Rolán & Peñas, 2001; Peñas et al., 2006). *Monophorus amicitiae* Romani, 2015 was described upon one specimen with dried soft parts and a few empty shells collected in bottom sediments at 30–240 m, originating from some localities around the Tuscan Archipelago. In comparison with *M. alboranensis*, it was reported to have a smaller shell with more cylindrical outline, uniformly coloured except the brownish base, smooth C4 and C5, and protoconch with at least one whorl less and a larger nucleus (Romani, 2015). Later, single shells of *M. amicitiae* were reported from Italy, respectively from Sicily (Delongueville & Scaillet, 2016), Salento (southern Apulia) (Trono, 2016) and Gulf of Lion (southern France) (Delongueville & Scaillet, 2021). These specimens are smaller than the type material and have sculptured C4 and C5 (C4 crenulated and C5 granulated, or both granulated). Another three shells from Greece, described by Manousis et al. (2018), also have similarly sculptured C4 and C5. Last, another shell from the Tuscan Archipelago (albeit with the apex detached), as well as other 6 intact shells originating from Salento peninsula, are overall very similar to *M. amicitiae* except for the sculptured basal cords. These discrepancies, together with the examination of some rich samples from the Adriatic Sea assignable to *M. alboranensis* as well as of *M. alboranensis* shells from the Alboran Sea, prompted a review of these taxa.

Material and methods

The material examined in the present paper was sorted out of bioclastic sediment samples collected manually by scuba divers and through analysis of by-catch of commercial trawling (Tuscan and Spanish material); by dredging within the frame of the INDEMARES Project; amidst the residuals of material collected during red coral fishing at 60–100 m depth by scuba divers (Croatian, Spanish and Moroccan material); from by-catch of lobster fishing vessels operating on coralligenous bottoms at 80–100 m depth (Apulian material). The analysed material is currently preserved in public institutions and private collections (as detailed under individual records). Identifications followed the literature and/or type material explained below. Updated taxonomy and nomenclature hereby used follow MolluscaBase (2021). Shells were examined through Labolan S.L., Lomo MBC-10 (Russia), Olympus SZ30 (Japan) and Olympus SZ61 (Japan) stereomicroscopes, whilst measurements were carried out by means of an ocular micrometer. Selected shells and their details were also examined with a scanning electron microscope (SEM), after air drying and mounting on SEM stubs. The teleoconch spiral cords nomenclature follows Marshall (1983). The protoconch whorls were counted following Verduin's (1977) method.

Abbreviations

Institutions - MNCN: Museo Nacional de Ciencias Naturales, Madrid, Spain; MNHN: Muséum national d'Histoire naturelle, Paris, France; MNHM: Museo di Storia Naturale di Milano, Milan, Italy.

Personal collections - AP: Attilio Pagli collection (Empoli, Italy); AR: Alessandro Raveggi collection (Firenze, Italy); CS: Carlo Sbrana collection (Livorno, Italy); DT: Daniele Trono collection (Copertino, Italy); FA: Franco Agamennone collection (Pescara, Italy); GB: Gabriele Macri collection (Scorrano, Italy); JP: Jakov Prkić collection (Split, Croatia); LR: Luigi Romani collection (Cappannori, Italy); PC: Paolo Crovato collection (Napoli, Italy); RS: Rino Stanić collection (Split, Croatia); SG: Sandro Gori (Livorno, Italy).

Morphometrics - C1–C7: spiral cords (numbered progressively from the one in adapical position); H: maximum height (in mm); HP: height of protoconch (in µm); NP: number of whorls of protoconch; NT: number of whorls of teleoconch; W: maximum width (in mm).

Other - sh(s): empty shell(s); lv(s): live collected specimen(s).

Material examined

Monophorus alboranensis Rolán & Peñas, 2001. SPAIN: 1 sh, holotype of *M. alboranensis*, H 8.0 mm, Alboran Sea, unspecified locality, 100–200 m (MNCN 15.05/44159) (Fig. 1. A); 1 sh, paratype of *M. alboranensis*, H 5.4 mm, same data as for holotype (MNHN-IM-2000-737) (Fig. 3. F); 1 sh, Alboran platform (35°53'24.0"N 3°04'40.8"W), 80 m, rhodolith beds, INDEMARES ALBORAN DR01, 08.IX.2011 (Fig. 3. E); 13 shs and fragments, Chafarinas Islands, 80–100 m, in PC. ITALY: 5 shs, holotype and 4 paratypes of *Monophorus amicitiae* Romani, 2015 (for details see original description) (Figs. 1. B, 2. H); 1 sh, Quercianella (Livorno), 20 m, in CS (Fig. 2. G); 1 sh, off Capraia Island (Livorno), 200 m, in AP [*M. cf. amicitiae*, in Romani, 2015] (Fig. 2. M); 2 shs, off W Capraia Island (Livorno), 200 m, in SG; 2 shs, off Porto Cesareo (Lecce), 80–100 m, in DT (Fig. 2. F); 1 sh, off Santa Maria di Leuca (Lecce), 120 m, in DT; 4 shs, off Porto Cesareo (Lecce), 80–100 m, in GM (Fig. 2. I); 2 shs (only protoconch and apical whorls preserved), Cannizzaro (Catania), 50 m, in LR. CROATIA: 40 shs, Mljet Island (Dubrovnik-Neretva), 70–100 m, red coral bottoms, in JP (Figs. 1. C, 2. C, 2. D, 2. J, 2. K, 2. L); 2 shs, Lastovo Island (Dubrovnik-Neretva), 80–90 m, red coral bottoms, in JP (Fig. 2. A); 7 shs, Lastovo Island (Dubrovnik-Neretva), 80–90 m, red coral bottoms, in RS (Fig. 2. B); 1 sh, Rivanj Channel (Zadar), 30 m, in JP; 1 sh, Omiš (Split-Dalmatia), 38 m, in JP.

Monophorus cf. erythrosoma (Bouchet & Guillemot, 1978). SPAIN: 1 sh, Almería (Alboran Sea), 50 m, in AP (Fig. 3. A); 4 shs, Secos de los Olivos (Almería), 80 m, in AP (Fig. 3. D); 6 shs, La Herradura (Granada), 40 m, in AR & SB (Fig. 3. B, 3C). MOROCCO: 1 sh, Moroccan coast of the Alboran Sea, unspecified locality, 80 m, in FA.

New data on *Monophorus alboranensis* Rolán & Peñas, 2001 (Gastropoda: Triphoridae)

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Abstract

Triphoridae is a very diverse family, whose taxonomy poses several challenges at the global level. The Mediterranean triphorid fauna is regarded as well known, with only three species described in the last two decades: *Monophorus alboranensis* Rolán & Peñas, 2001, *Monophorus amicitiae* Romani, 2015 and *Coriophora lessepsiana* Albano, Bakker & Sabelli, 2021. *M. alboranensis* and *M. amicitiae* were described based on relatively few shells, originating from the Alboran Sea (Western Mediterranean Sea) and the Tuscan Archipelago (Northern Mediterranean Sea), respectively. *M. alboranensis* is well characterized with respect to the other congeners. *M. amicitiae*, though recognized as close to *M. alboranensis*, was diagnosed by differences in size and outline, sculptural features, and morphology of the protoconch. The discovery of further material of *M. amicitiae* points out a wider morphological variability, partially overlapping that of *M. alboranensis*, whose type material was re-examined together with further topotypical shells. Finally, the examination of some rich *Monophorus* lots from the Adriatic Sea assignable to *M. alboranensis*, allowed to recognize a morphological continuum between the two taxa. Despite the lack of anatomical and molecular data, it can therefore be supposed that they represent a single species. This case remarks the risks in describing species based exclusively on shell morphology, without an adequate number of specimens and direct comparison of the type material of related species. This applies especially to groups comprising many similar species or potentially displaying a high level of morphological plasticity.

Keywords

Shell, morphological variability, species delimitation, Mediterranean Sea, Caenogastropoda.

Riassunto

I Triphoridae sono una famiglia molto diversificata, la cui tassonomia pone diverse sfide a livello globale. La fauna mediterranea dei triforidi viene considerata ben nota, con solo tre specie descritte negli ultimi due decenni: *Monophorus alboranensis* Rolán & Peñas, 2001, *Monophorus amicitiae* Romani, 2015 e *Coriophora lessepsiana* Albano, Bakker & Sabelli, 2021. *M. alboranensis* e *M. amicitiae* sono stati descritti sulla base di poche conchiglie, provenienti rispettivamente dal Mare di Alboran (Mar Mediterraneo occidentale) e dall'Arcipelago Toscano (Mar Mediterraneo settentrionale). *M. alboranensis* è ben caratterizzato rispetto agli altri congeneri. *M. amicitiae*, anche se riconosciuto come simile a *M. alboranensis*, è stato diagnosticato per differenze delle dimensioni e del profilo, dei caratteri della scultura e della morfologia della protoconca. La scoperta di ulteriore materiale di *M. amicitiae* evidenzia una più ampia variabilità morfologica, parzialmente sovrapponibile a quella di *M. alboranensis*, il cui materiale tipo è stato riesaminato insieme ad altre conchiglie topotipiche. Infine, l'esame di alcuni ricchi lotti di *Monophorus* dell'Adriatico assegnabili a *M. alboranensis*, ha permesso di evidenziare un continuum morfologico tra i due taxa. Nonostante la mancanza di dati anatomici e molecolari, si può quindi supporre che essi rappresentino un'unica specie. Questo caso sottolinea i rischi di descrivere le specie basandosi esclusivamente sulla morfologia della conchiglia, senza un numero adeguato di esemplari e un confronto diretto del materiale tipo di specie affini. Questo vale soprattutto per i gruppi che comprendono molte specie simili o che potenzialmente mostrano un alto livello di plasticità morfologica.

Parole chiave

Conchiglia, variabilità morfologica, delimitazione della specie, Mar Mediterraneo, Caenogastropoda.

Introduction

The family Triphoridae is a diverse group of mostly left-coiled, spongivorous, marine gastropods with a world-wide distribution (Wells, 1998; MolluscaBase, 2021a). The taxonomy of Triphoridae poses several challenges due to the huge number of (morpho)species, small size, hardly-detectable diagnostic characters, specialized habits, cryptic diversity, often poorly known/unsuitable type material, and nomenclatural hurdles (Bouchet & Strong, 2010; Albano et al., 2011, 2019).

After the seminal revisions by Bouchet (1985, 1997), Euro-Mediterranean triphorids are generally regarded as well known, with only two *Monophorus* species described in recent years (Rolán & Peñas, 2001; Romani, 2015).

Monophorus alboranensis Rolán & Peñas, 2001 was described upon some empty shells found in sediments collected at 100-200 m, in the Alboran Sea (unspecified locality), and one shell from Almeria Bay, 50 m. Later, it was recorded from coralligenous bottoms around Alboran Island. It is diagnosed by its chromatic pattern (light

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References

ALBUQUERQUE M., BORGES J. P. & CALADO G., 2009. *Moluscos Marinhos. Atlas das Ilhas Selvagens*. Direcção Regional do Ambiente: Funchal, Portugal: 309 pp.

AMATI B. & OLIVERIO M., 2020. Description of *Crisilla didyme* n. sp. from the Mediterranean Sea (Mollusca, Gastropoda, Rissoidae). *Iberus*, **38** (1): 19–27.

APOLLONI M., SMRIGLIO C., AMATI B., LUGLIÈ L., NOFRONI I., TRINGALI L. P., MARIOTTINI P. & OLIVERIO M., 2018. Catalogue of the primary types of marine molluscan taxa described by Tommaso Allery di Maria, Marquis of Monterosato, deposited in the Museo Civico di Zoologia, roma. *Zootaxa*, **4477** (1): 1–138.

GOFAS S. & OLIVER J.D., 2011. Familia Rissoidae. In Gofas S., Moreno D. & Salas C. (eds): *Moluscos marinos de Andalucía*. Vol. 1. Servicio de Publicaciones e Intercambio Científico, Universidad de Málaga, pp. 167–194.

HADLEY A., 2006. Combine ZP public domain image processing software. Available from <https://web.archive.org/web/20160221032141/http://www.hadleyweb.pwp.blueyonder.co.uk/>

MOLLUSCABASE (2021) *Crisilla* Monterosato, 1917. Accessed through: World Register of Marine Species. Available from: <http://www.molluscabase.org/aphia.php?p=taxdetails&id=138446> on 2021.03.17.

MONTAGU G., 1808. *Supplement to Testacea Britannica*. White, London. 184 pp., pls. 17–30.

MONTEROSATO T.A. (di), 1884. Conchiglie littorali mediterranee. *Il Naturalista Siciliano*, **3** (8): 227–231.

OLIVER J.D., ROLÁN E. & TEMPLADO J., 2019. The littoral species of the genus *Crisilla* Monterosato, 1917 (Caenogastropoda, Rissoidae) in Azores, Madeira, Selvagens and Canary Islands with notes on West African taxa and the description of four new species. *Iberus*, **37** (1): 23–80.

OLIVER J.D., TEMPLADO J. & KERSTING D.-K., 2012. Gasterópodos marinos de las islas Columbretes (Mediterráneo occidental). *Iberus*, **30** (2): 49–87.

ROMANI L. & PAGLI A., 2020. Repetita juvant: once again on *Crisilla cristallinula* (Manzoni, 1868) and *Crisilla marioni* (Fasulo & Gaglioli, 1987) (Rissoidae: Gastropoda). *Alleryana* **38** (2): 98–102.

ROMANI R., RAVEGGI A., SCAPERROTTA M. & BARTOLINI S., 2018. Contributo alla conoscenza della malacofauna marina delle isole adriatiche. 1. Nota sui micromolluschi marini conchiferi rinvenuti sulla costa settentrionale dell’isola di Lastovo [Lagosta] (Croazia, Mar Adriatico Sud-Orientale). *Alleryana*, **36** (1): 1–22.

SCAPERROTTA M., BARTOLINI S. & BOGI C., 2011. *Accrescimenti. Stadi di accrescimento dei molluschi marini del Mediterraneo. Volume III*. l’Informatore Piceno, Ancona, 184 pp.

SCAPERROTTA M., BARTOLINI S. & BOGI C., 2015. *Accrescimenti. Stadi di accrescimento dei molluschi marini del Mediterraneo. Volume VII*. l’Informatore Piceno, Ancona, 192 pp.

SCAPERROTTA M., BARTOLINI S. & BOGI C., 2016. *Accrescimenti. Stadi di accrescimento dei molluschi marini del Mediterraneo. Volume VIII*. l’Informatore Piceno, Ancona, 208 pp.

SCAPERROTTA M., BARTOLINI S. & BOGI C., 2019. *Accrescimenti. Stadi di accrescimento dei molluschi marini del Mediterraneo. Volume X*. l’Informatore Piceno, Ancona, 212 pp.

SCUDERI D. & AMATI B., 2012. Rediscovery and re-evaluation of a “ghost” taxon: the case of *Rissoa galvagni* Aradas et Maggiore, 1844 (Caenogastropoda Rissoidae). *Biodiversity Journal*, **3** (4): 511–520.

VERDUIN A., 1984. On the taxonomy of some recent European marine species of the genus *Cingula* s. l. *Basteria*, **48**: 37–87.

VERDUIN A., 1988. On the taxonomy of some Rissoacean species from Europe, Madeira and the Canary Islands (Gastropoda Prosobranchia). *Basteria*, **52**: 9–35.

A new species of the genus *Crisilla* Monterosato, 1917 from the Mediterranean Sea (Gastropoda: Rissoidae)

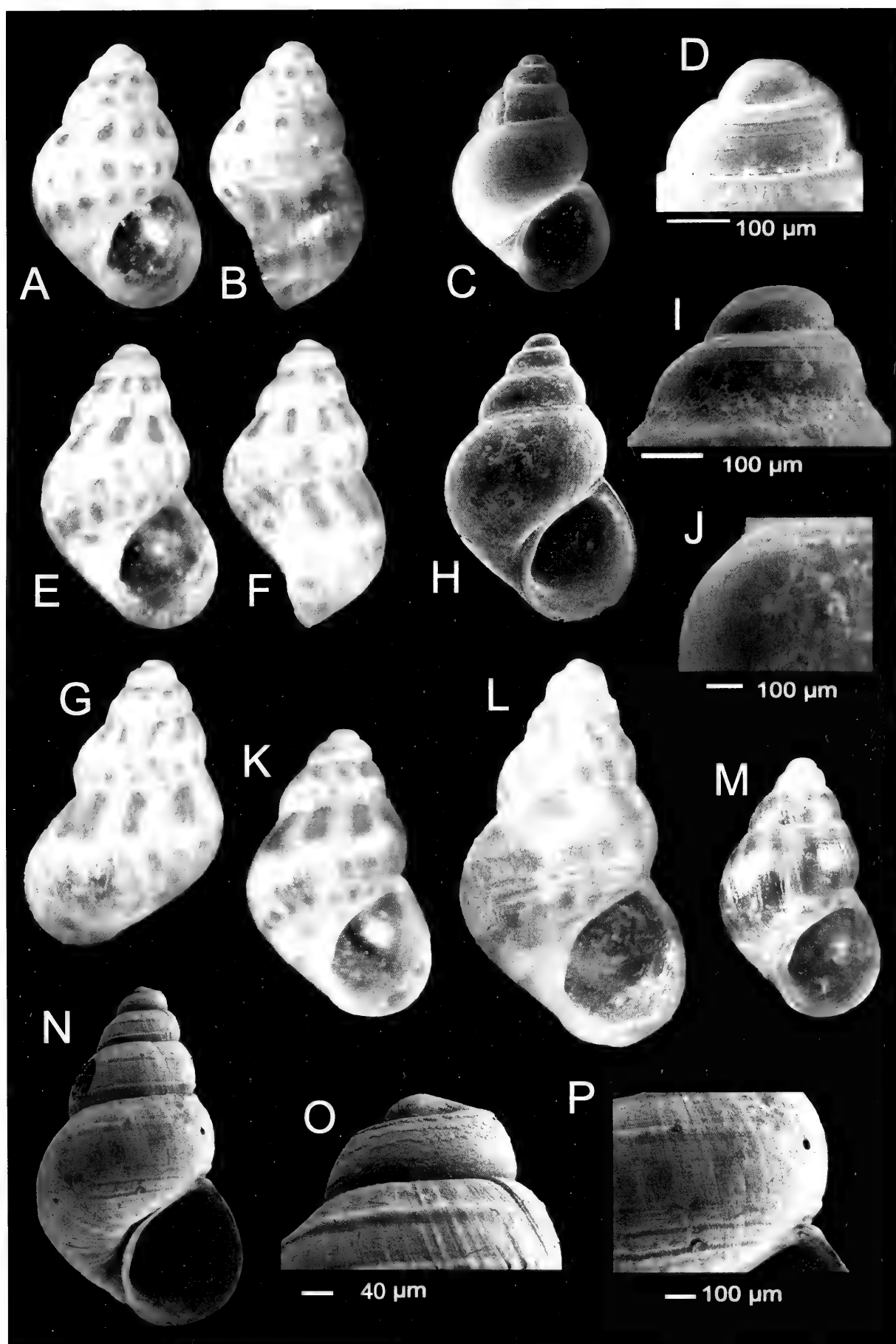


Fig. 3. A-P. *Crisilla* spp. A-D. *Crisilla ramosorum* Oliver, Templado & Kersting, 2012; **A, B.** Los Escullos, Almeria (Spain) 4-6 m depth, height 1.33 mm (BA); **C, D.** *Crisilla ramosorum* Oliver, Templado & Kersting, 2012, holotype, Columbretes Islands (Spain) (SEM) height 1.20 mm (MNCN.15.05/60050), **E-G.** *Crisilla didyme* Amati & Oliverio, 2020, holotype, Salina Island, Sicily, "Gamberetti" Cave, 35 m depth, height 1.45 mm (MNHN-IM-2000-35035), **H-J.** *Crisilla didyme* Amati & Oliverio, 2020, paratype, type locality (SEM), height 1.45 mm (MCZR-M-00092/P); **K.** *Crisilla didyme* Amati & Oliverio, 2020 Cape Palinuro 18 m depth, height 1.40 mm (BA); **L.** *Crisilla beniamina* (Monterosato 1884), Salina Island, Sicily, "Gamberetti" Cave, 35 m depth, height 1.95 mm (BA); **M.** *Crisilla aartseni* (Verduin, 1984), Tarifa, 1.30 mm (SB-MS); **N-P.** *Crisilla beniamina* (Monterosato 1884), Salina Island, Sicily, "Gamberetti" Cave, 35 m depth (SEM), height 1.73 mm (BA).

ture of the protoconch nucleus, with slightly wavy spiral threads, is most evident in the paratype A (**Fig. 2. H**). The height ranges between 1.20 mm and 1.36 mm. The shoulder ends with an angle on the upper third of the first whorl, present in all the specimens, but more pronounced in the paratype A. Coloration is rather constant, but in two specimens (paratypes F, G), a fourth series of small reddish blotches can be seen on the last whorl in the periumbilical area. On the last whorl, the subsutural blotches or each spiral series are 7-11. Columellar and umbilical area often whitish.

The new species is easily comparable with some congeners: *C. beniamina* (Monterosato 1884), *C. aartseni* (Verduin 1984), *C. ramosorum* Oliver, Templado & Kersting, 2012, *C. didyme* Amati & Oliverio, 2020, *C. ugesae* (Verduin, 1988), *C. ugesae* sensu Auctores [e.g.: Albuquerque et al., 2009; Oliver et al., 2019 'partim'; non *C. ugesae* (Verduin, 1988)], and *Crisilla* sp. (Romani et al., 2018: 15, fig. 8c).

C. beniamina (Monterosato, 1884: 228; see also Scaperrotta et al., 2011: 70, 5 unnumbered figures; Appolloni et al., 2018: 103, figs 13 K-L; Romani et al., 2018: 15, figs 8 e-h; Oliver et al., 2019: 27, 74, figs 1 e, f, 30 d) (**Fig. 3. L, N-P**) differs from *C. hiera* in its larger size (exceeding 2 mm in height) and in its protoconch sculpture of granules grouped in series of spiral threads over the whole surface, more marked towards the end of the protoconch, with one thread on the adapical quarter generally more evident *vs* slightly wavy spiral threads on the nucleus, the rest of protoconch smooth except for growth striae over the entire surface in *C. hiera*; in the teleoconch with two spiral cords in the median area of the whorls, and many very fine spiral cordlets between the two main cords and on the base *vs* sparse, very fine and obsolete spiral cordlets on the basal area in *C. hiera*. *C. beniamina* has been found sympatric with con *C. hiera* sp. n.

C. aartseni (Verduin, 1984: 74, fig. 8; see also Gofas & Oliver, 2011: 190, 3 unnumbered figures; Oliver et al., 2012: 61, figs 28-29; Scaperrotta et al., 2015: 63, 6 unnumbered figures; Oliver et al., 2019: 27, figs 1 K, L; Amati & Oliverio, 2020: 25, fig. 2C) (**Fig. 3. M**) differs from *C. hiera* in its protoconch sculpture of 10-14 narrow but strong, tightly packed spiral cordlets *vs* nucleus with spiral threads, the rest of protoconch smooth except for growth striae over the entire surface in *C. hiera*; in the lack of spiral sculpture on the teleoconch *vs* sparse, very fine and obsolete spiral cordlets on the basal area in *C. hiera*.

C. ramosorum (Oliver et al., 2012: 61, figs 23-27; see also Oliver et al., 2019: 27, figs 1 I, J) [not Scaperrotta et al., 2019: 150 fig. G] (**Fig. 3. A-D**) differs from *C. hiera* in its protoconch sculpture of 4-6 spiral cordlets, some interrupted *vs* nucleus with spiral threads, the rest of protoconch smooth except for growth striae over the entire surface in *C. hiera*; in its teleoconch with very weak spiral cords on the entire whorl *vs* sparse, very fine and obsolete spiral cordlets on the basal area of the last whorl in *C. hiera*.

C. ugesae (Verduin, 1988: 31, figs 32, 36, 40) from the

Canary Islands differs by *C. hiera* in its solid shell with slightly convex whorls and base, slender profile (RH/W = 1.708-1.750), and outer lip flattened *vs* shell not very solid with convex whorls, slightly concave base, slightly slender profile (RH/W = 1.463-1.545), outer lip expanded laterally, not flattened. *C. ugesae* can attain larger size (1.30-1.70 mm) *vs* 1.20-1.36 mm in *C. hiera*. *C. ugesae* has very fine and dense spiral striae under the periphery *vs* thin and obsolete spiral cordlets on the basal area; acute *vs* globose apex; 3-4 series of darker spots, small and narrow spirals arranged in a herringbone pattern *vs* 3-4 series of larger and broadly quadrangular red-brownish spots arranged orthogonally. Under the name *C. ugesae*, some Authors have reported from Selvagens Islands a different species (e.g.: Albuquerque et al., 2009: 127, two unnumbered figures; Oliver et al., 2019: figs 21, 29 KL, 31P). *C. ugesae* sensu AA non (Verduin, 1988) differs from *C. ugesae* Verduin, 1988 in its less robust shell with a concave base *vs* a thicker more robust shell with a convex base; its apparently smooth surface, with faint spiral striae across the surface *vs* very fine and dense spiral striae below the periphery. It differs from *C. hiera* in its more acute and slender profile (RH/W = 1.700-1.857), less convex whorls, slightly convex narrow base *vs* less acute profile, more convex whorls, broad base, less slender profile (RH/W = 1.463-1.545), more convex whorls and wider, slightly concave base; apparently smooth surface, with faint spiral lines all over the surface *vs* fine and obsolete spiral cordlets only on the basal area; rather acute *vs* globose apex; four spiral rows of large reddish spots *vs* 3-4 series of larger, broadly quadrangular red-brown spots arranged orthogonally.

Some specimens ascribed to an undetermined *Crisilla* sp. from Lastovo Island (Croatia), have been briefly described and excellently figured by Romani et al. (2018: 15, fig 8c) (see also Amati & Oliverio, 2020: 26). These specimens closely resemble the new species; however, they are diagnosed by the presence of a single weak basal cord *vs* sparse, very fine and obsolete spiral cordlets on the basal area in *C. hiera*, and the more numerous colour blotches on the last whorl (c. 16, *vs* 7-11 in *C. hiera*), suggesting they may represent a further undescribed species.

C. didyme (Amati & Oliverio, 2020: 21, figs 1A-K) (**Fig. 3. E-K**) differs from *C. hiera* in its protoconch with 4-5 fine, spaced, spiral cordlets of varying strength, often interrupted *vs* nucleus with spiral threads, the rest of protoconch smooth except for growth striae over the entire surface in *C. hiera*; in its teleoconch with rare and very thin spiral cordlets on the subutural area of the last whorl and smooth base *vs* rare and very fine spiral cordlets on the basal area of the last whorl in *C. hiera*.

We report here a new record for *C. didyme* (**Fig. 2. K**), so far known only from the type locality, at the Aeolian Islands. We have found 38 shells in a sample of bioclastic sediment collected in the submarine cave 'Cattedrale II' (18 m depth, 40°01'41"N 15°16'06"E, 30 May - 02 June 2003: **Fig. 1**) at Cape Palinuro.

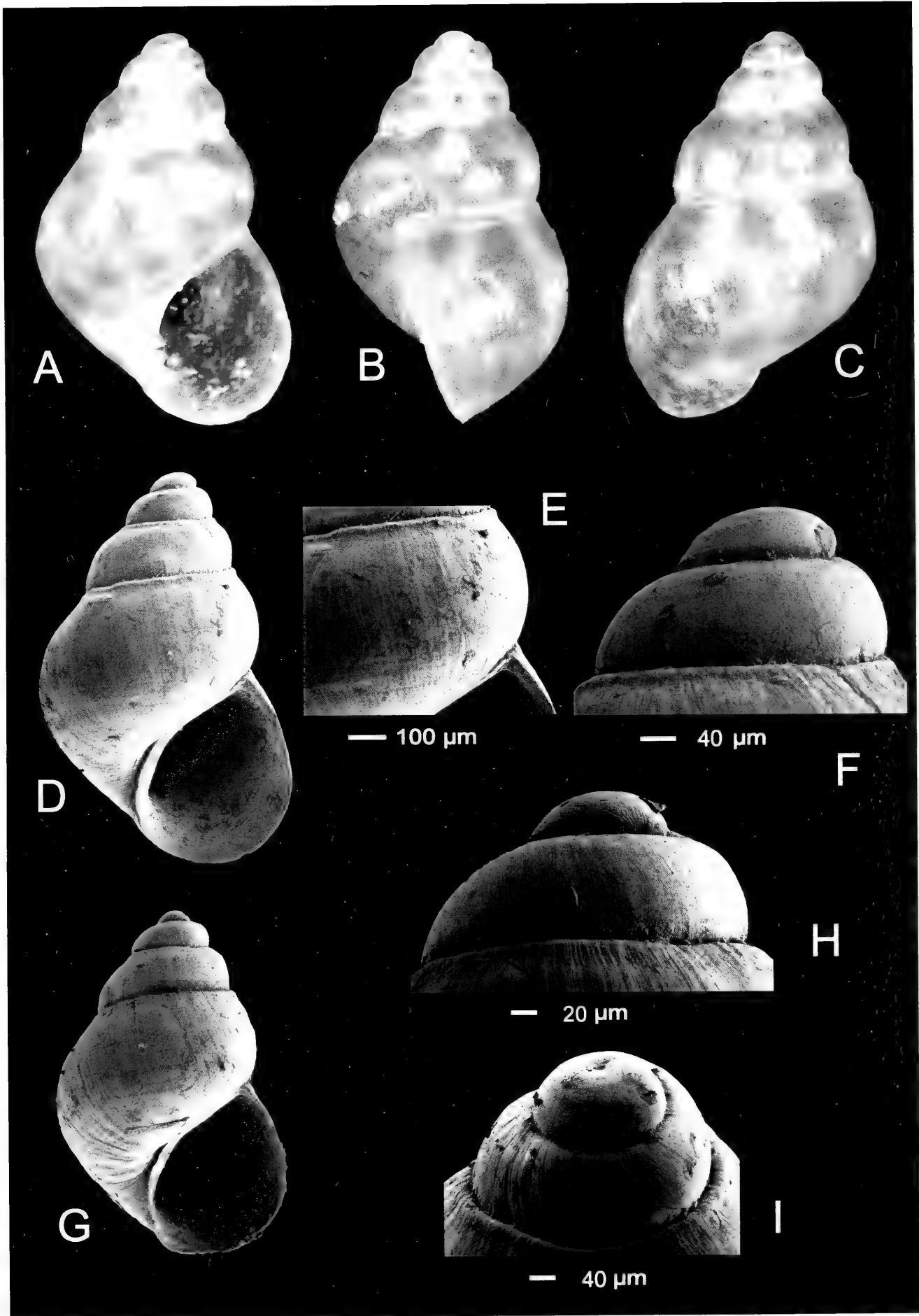


Fig. 2 A-I. *Crisilla hiera* n. sp. A-F holotype, height 1.36 mm (MNHN-IM-2000-36728); G-H. paratype A, height 1.20 mm (BA); I. paratype B, height 1.20 mm (MO) (all from the type locality).

Distribution

So far known only on empty shells from the type locality: Marettimo Island, Southern Tyrrhenian Sea.

Description of the holotype

Shell (Fig. 2. A-I) small for the genus, not very solid, translucent, height 1.36 mm, width 0.88 mm, aperture height 0.68 mm, height/width ratio 1.545, height/aperture height ratio 2.000, glossy, ovate-conic, of 2.4 convex whorls, suture impressed, shoulder very slightly angled on first teleoconch whorl.

Protoconch paucispiral (Fig. 2. F) of 1.4 whorls, height 0.200 mm, diameter of nucleus 0.125 mm, diameter of first half whorl 0.212 mm, maximum diameter 0.337 mm; nucleus (Fig. 2. F) with weak slightly wavy spiral threads, partially anastomized; rest of protoconch with only growth striae over the entire surface.

Protoconch-teleoconch boundary prosocline, slightly marked (Fig. 2. I paratype A).

Teleoconch with a subsutural cordlet on all whorls (Fig. 2. D, E), sparse, fine and obsolete spiral cordlets on basal area of the last whorl, and weak prosocline growth striae (Fig. 2. E).

Outer lip prosocline, simple, weakly thickened posteriorly, with sharp edge, internally smooth. Umbilical chink absent.

Columella slightly arched.

Colour amber-yellow background, with three series of

Species
<i>Crisilla aartseni</i> (Verduin 1984)
<i>Crisilla beniamina</i> (Monterosato 1884)
<i>Crisilla chiarellii</i> (Cecalupo & Quadri 1995)
<i>Crisilla didyme</i> Amati & Oliverio, 2020
<i>Crisilla gagliniae</i> (Amati, 1985)
<i>Crisilla galvagni</i> (Aradas & Maggiore, 1844)
<i>Crisilla hiera</i> n. sp.
<i>Crisilla maculata</i> (Monterosato, 1869)
<i>Crisilla marioni</i> (Fasulo & Gaglini 1987)
<i>Crisilla ramosorum</i> Oliver, Templado & Kersting, 2012
<i>Crisilla semistriata</i> (Montagu, 1808)
<i>Crisilla simulans</i> (Locard, 1886)

Table 1. List of the Recent Mediterranean species of the genus *Crisilla*.

red-brownish broadly quadrangular blotches (seven on last whorl; two series visible on first whorls), subsutural ones slightly larger than others.

Operculum and soft parts unknown.

Remarks

Eight specimens were examined, including six adults used for the measurements (Tab. 2), and two juveniles. The variability of shell morphology is low. The sculp-

Protoconch	holotype (Figs 2A-F)	paratype A (Figs2G,H)	paratype B (Fig. 2I)	paratype E	paratype F	paratype G	Min-Max	Mean	Std
height	0.200	0.175	0.250	0.225	0.237	0.200	0.175-0.250	0.215	0.028
diameter of nucleus	0.125	0.100	0.095	0.120	0.112	0.112	0.095-0.125	0.111	0.011
diameter of first half whorl	0.212	0.175	0.170	0.175	0.195	0.195	0.170-0.212	0.187	0.016
maximum diameter	0.337	0.287	0.325	0.325	0.312	0.295	0.287-0.337	0.314	0.019
number of whorls	1.40	1.30	1.35	1.35	1.30	1.30	1.30-1.40	1.333	0. 0825
Teleoconch									
height	1.36	1.20	1.20	1.25	1.27	1.22	1.20-1.36	1.25	0.061
width	0.88	0.78	0.82	0.81	0.83	0.81	0.78-0.88	0.82	0.033
height of aperture	0.68	0.56	0.58	0.60	0.62	0.61	0.56-0.68	0.61	0.041
height/width ratio	1.545	1.538	1.463	1.543	1.530	1.506	1.463-1.545	1.521	0.032
height/height aperture ratio	2.000	2.142	2.068	2.083	2.048	2.000	2.000-2.142	2.057	0.054
number of whorls	2.40	2.40	2.30	2.30	2.40	2.25	2.25-2.40	2.34	0.066

Table 2. Measurements of protoconchs and teleoconchs of *Crisilla hiera* n. sp., in mm, with range, mean and standard deviation.

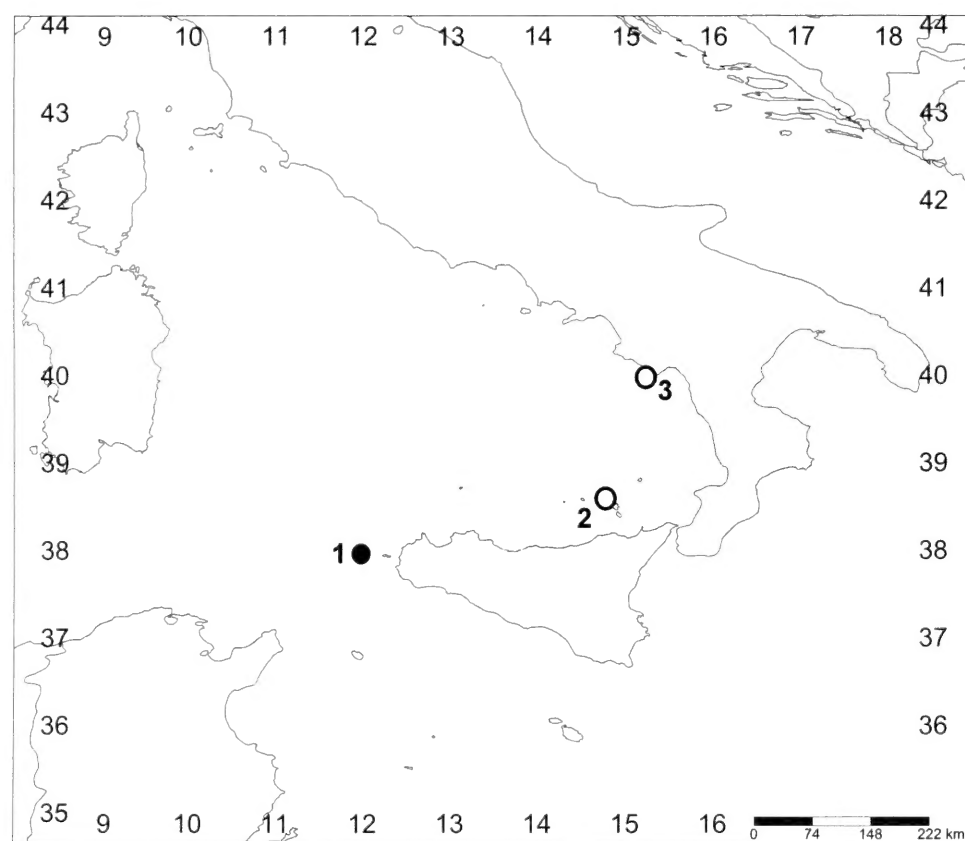


Fig. 1. Known distribution of *Crisilla hiera* sp. n., (Marettimo Is., type locality, closed circle **1**) and *Crisilla didyme* Amati & Oliverio, 2020 (Salina Is., type locality, open circle **2**); Cape Palinuro, new record, open circle **3**).

SB-MS: Stefano Bartolini-Maria Scaperrotta collection (Firenze, Italy);

SEM: scanning electron microscope;

sh: empty shell(s).

Systematic part

Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Superfamily Rissooidea Gray, 1847
Family Rissoidae Gray, 1847

Genus *Crisilla* Monterosato, 1917

type-species: *Turbo semistriatus* Montagu, 1808: 136 (by monotypy)

= *Crisillosetia* F. Nordsieck, 1972, type species: *Setia* (*Crisillosetia*) *pseudocingulata* F. Nordsieck, 1972 (by original designation).

Diagnosis

Shell of small size for the family (ca 2 mm in height), from scarcely to very robust, with weak spiral sculpture and occasionally with weak axial sculpture.

Remarks

The north-eastern Atlantic species have been divided into three morphologically based groups by Oliver et al. (2018), recently used for merely comparative purposes

by Amati & Oliverio (2020): (1) species similar to *Alvanina*, including taxa with weak spiral and axial sculpture and with a thick shell; (2) typical *Crisilla* species, including taxa with only spiral sculpture, strong or weak; (3) species similar to *Setia*, including taxa with thin and small shell, lacking axial sculpture and with very weak or absent spiral sculpture. Although the limits among those groups are probably weak, in this scheme, *Crisilla hiera* n. sp. may be included in the 'typical *Crisilla* species' group.

Crisilla hiera n. sp.

(Fig. 2. A-I, Tables 1, 2)

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Type material

Holotype (MNHN-IM-2000-36728), H 1.36 mm, W 0.88 mm (Fig. 2. A-F); 5 paratypes (BA); 2 paratypes (MO) (legit M. Oliverio). All from type locality.

Type locality

Cattedrale Cave, Marettimo Island, Aegadian Islands (Sicily), 37°56'45" N, 12°4'42" E, 28 m depth (Fig. 1).

Etymology

From the old Greek name of Marettimo Island (Ἱερά νῆσος, Hierà nésos) meaning 'Holy island'. Used as a noun in apposition.

A new species of the genus *Crisilla* Monterosato, 1917 from the Mediterranean Sea (Gastropoda: Rissoidae)

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Abstract

A new Mediterranean species of the genus *Crisilla* Monterosato, 1917 (Rissooidea, Rissoidae) is described: *Crisilla hiera* n. sp. All known specimens are empty shells retrieved from a sample of bioclastic sand collected in a submarine cave at Marettimo Island (type locality). It is compared with the most similar congeners from the Mediterranean Sea, such as *Crisilla beniamina* (Monterosato 1884), *C. aartseni* (Verduin 1984), *C. ramosorum* Oliver, Templado & Kersting, 2012, *C. didyme* Amati & Oliverio, 2020 and *Crisilla* sp. (Romani et al., 2018), and from the Eastern Atlantic Ocean, such as *C. ugesae* (Verduin, 1988) and *C. ugesae* sensu Auctores. *Crisilla didyme* is first reported from a site different from the type locality, at Capo Palinuro (southern Tyrrhenian Sea).

Key words

Gastropoda; Rissoidae; Mediterranean Sea; *Crisilla*; new species; taxonomy

Riassunto

Viene descritta una nuova specie mediterranea del genere *Crisilla* Monterosato, 1917 (Rissooidea, Rissoidae): *Crisilla hiera* n. sp. Tutti gli esemplari, recuperati da un campione di sabbia bioclastica raccolto in una grotta sottomarina all'Isola di Marettimo (località tipo), erano privi delle parti molli. Viene confrontata con le congeneri più simili del Mar Mediterraneo, come *Crisilla beniamina* (Monterosato 1884), *C. aartseni* (Verduin 1984), *C. ramosorum* Oliver, Templado & Kersting, 2012, *C. didyme* Amati & Oliverio, 2020 e *Crisilla* sp. (Romani et al., 2018), e dell'Oceano Atlantico orientale, come *C. ugesae* (Verduin, 1988) e *C. ugesae* sensu Auctores. *Crisilla didyme* viene segnalata per la prima volta da un sito diverso dalla località tipo, a Capo Palinuro (Tirreno meridionale).

Parole chiave

Gastropoda; Rissoidae; Mar Mediterraneo; *Crisilla*; nuova specie; tassonomia.

Introduction

The genus *Crisilla* Monterosato, 1917 (type species *Turbo semistriatus* Montagu, 1808) includes 39 Recent recognised species of small rissoids from the north-eastern Atlantic and the Western Indian Ocean (MolluscaBase, 2021), eleven of which are recorded in the Mediterranean Sea (Table 1). They live from the lower intertidal to the bathyal bottoms (and probably also abyssal with the Atlantic *Crisilla amphiglypha* Bouchet & Warén, 1993). This group has received particular attention in the last decade and has been extensively revised (Oliver, Rolán & Templado, 2019; Scaperrotta, Bartolini & Bogi, 2011, 2015, 2016, 2019; Oliver, Templado & Kersting, 2012; Scuderi & Amati, 2013; Amati & Oliverio, 2020; Romani & Pagli, 2020).

We report here the description of a new species, found in a sample of bioclastic sediment collected in a submarine cave at Marettimo Island (Aegadian Islands). The new species is very similar to *Crisilla ramosorum* Oliver, Templado & Kersting, 2010 and to *Crisilla didyme* Amati & Oliverio, 2020 but easily differentiated by some shell features.

Materials and methods

A sample of bioclastic sediment was collected in July 2011, in the deepest part of a dark cave at Marettimo Island at 28 m depth (Fig. 1, see type locality for further details), rinsed in freshwater and air dried, and sorted under a stereomicroscope. The specimens here studied are stored in public and private collections. Photographs have been taken with a Sony Cyber-shot DSC-W110 digital camera mounted on a Kyowa KBS and a Kyowa SDZ-P stereomicroscopes, edited with the software Combine-Z (Hadley, 2006). Most SEM photographs were taken with a FE-SEM ZEISS Sigma Gemini 300 at the Interdepartmental Laboratory of Electron Microscopy (LIME, University "Roma Tre", Rome, Italy). Current systematics is based on the World Register of Marine Species (MolluscaBase, 2021).

Abbreviations and acronyms

BA: Bruno Amati collection (Roma, Italy);

MO: Marco Oliverio collection (Roma, Italy);

MNHN: National Museum of Natural History (Paris, France);

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Example of systematic hierarchy and synonymy:

Family Cardiidae Lamarck, 1809

Subfamily Cardiinae Lamarck, 1809

Genus *Acanthocardia* Gray, 1853

(type species *Cardium aculeatum* Linné, 1758)

Cardium indicum Lamarck, 1819

(Fig. 1. A-D, Fig. 2. C)

Cardium hians Brocchi, 1814: p. 508, pl. 13, fig. 6 (non Spengler, 1799).

Cardium indicum Lamarck, 1819: p. 4.

Cardium (Cardium) indicum Lamarck – Fischer-Piette, 1977: p. 112, pl. 10, fig. 4 (type).

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... as known in literature (Ross et al., 1993; Rosenberg, 1995, 1997; Michelini & Andriani, 2000)

... the original illustration (Torwald, 1879: p. 56, pl. 2, fig. 5).

Example of references:

SALAS C., 1996. Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions. *Haliotis*, **25**: 33-100.

GRILL B. & ZUSCHIN M., 2001. Modern shallow- to deep-water bivalve death assemblages in the Red Sea – ecology and biogeography. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **168**: 75-96.

BOSS K.J., 1982. Mollusca, in Parker S.P. (ed.), *Synopsis and Classification of Living Organisms*. Vol. 1. McGraw-Hill, New York: 945-1166.

CARTER J.G., CAMPBELL D.C. & CAMPBELL M.R. 2000. Cladistic perspectives on early bivalve evolution, in Harper E.M., Taylor J.D. & Crame J.A. (eds), *The Evolutionary Biology of the Bivalvia*. *Geological Society, London, Special Publications*, **177**: 47-95.

VOKES H.E., 1980. *Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and update)*. Paleontological Research Institution, Ithaca, Edwards Brothers Inc., 307 pp.

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